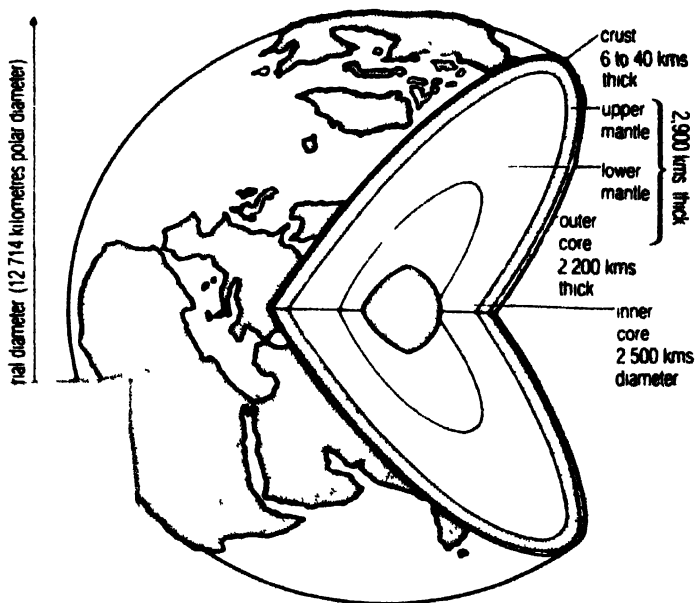


GOYL SazB

# DICTIONARY OF GEOLOGY



**Mary Hoffman**





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## The Major Divisions of Geologic Time, and the Development of Life Forms As Shown By Fossils

Era	System and Period		Distinctive Features	Million Years Ago
CENOZOIC	QUATERNARY		Early man; modern man in last 10,000 years	1.8
	TERTIARY		"Age of Mammals"	
MESOZOIC	CRETACEOUS		First flowering plants; greatest development of dinosaurs and ammonites, followed by extinction	65
	JURASSIC		First birds, first mammals; abundant dinosaurs and ammonites	140
	TRIASSIC		First dinosaurs, abundant coniferous trees	190
PALEOZOIC	PERMIAN		Extinction of trilobites and many other types of marine animals	230
	CARBONIFEROUS	PENNSYLVANIAN	Great coal forests; abundant insects, first reptiles	280
		MISSISSIPPIAN	Sharks and amphibians; large primitive trees	310
	DEVONIAN		First amphibians and ammonites	345
	SILURIAN		First plants and animals on land	405
	ORDOVICIAN		First fishes	425
	CAMBRIAN		First abundant record of marine invertebrates; trilobites dominant	500
	PRECAMBRIAN		Very few fossils: primitive aquatic plants; oldest fossils (bacteria, algae) about 3,100 million years	570



## A

**aa** (a'-a [ah'-ah]) A Hawaiian term for lava flows typified by a rough, jagged, spinose, clinkery surface. Cf: *pahoehoe*.

**a axis** 1. One of the crystallographic axes used as reference in crystal description. It is the axis that is oriented horizontally, front to back. 2. In deformed rocks, the direction of tectonic transport, i.e. of maximum displacement, like the direction in which cards slide over one another. Striae in a slickensided surface are parallel to *a*.

**abaxial** (ab-ax'-i-al) Facing away from, or situated on the outside of, the axis of an organ, plant, or invertebrate; dorsal or anterior. Ant. *adaxial*.

**Abbe refractometer** An instrument used for determining the refractive index of liquids, minerals, and gemstones. Its operation is based on measurement of the *critical angle*.

**ablation** (ab-la'-tion) 1. All processes by which snow and ice are lost from a glacier; also, the amount lost. Syn: *wastage*. 2. Removal of molten surface layers of meteorites by vaporization during flight through the atmosphere.

**ablation moraine** An uneven pile or continuous layer of *ablation till*, either overlying ice in the ablation area or resting on ground moraine derived from the same glacier.

**aboral** (ab-o'-ral) 1. Located op-

posite to or directed away from the mouth of an invertebrate. Cf: *adoral*. 2. Toward the underside of a conodont element.

**ab-plane** In deformed rocks, the surface along which differential movement takes place. *a* is the direction of displacement—that is, the direction of tectonic transport; *b* lies in this surface of movement and is perpendicular to *a*.

**abrasion** (ab-ra'-sion) The mechanical wearing or grinding away of rock surfaces by the friction and impact of rock particles transported by wind, ice, waves, running water, or gravity. Syn: *corrasion*. Also, the effect of abrading, as the abrasion left by glacial action. Verb *abrade*.

**abrasion pH** Acidity resulting from OH<sup>-</sup> or H<sup>+</sup> ions being adsorbed at the surfaces of finely ground minerals suspended in water.

**absarokite** (ab-sa'-ro-kite) A basaltic rock, composed of phenocrysts of olivine and clinopyroxene in a groundmass of labradorite with alkali feldspar rims, olivine, and some leucite. Absarokite grades into shoshonite with a decrease in the olivine content and with the presence of some dark-colored glass, and into banakite with a decrease in the olivine and augite.

**absolute age** (ab'-so-lute) The geologic age of a fossil, rock, feature, or event given in units of time, usually years. Commonly refers to ages determined radiometrical-

ly, but may also refer to ages obtained from tree rings, varves, etc. The term is in disfavor, as it implies a certainty or exactness that may not be possible to achieve. Cf: *relative age*.

**absolute humidity** The content of water vapor in air, expressed as the mass of water per unit volume of air. Cf: *relative humidity*.

**absolute permeability** The ability of a rock to conduct a fluid, e.g. gas, at 100% saturation with that fluid. See also: *effective permeability*; *relative permeability*.

**absolute temperature** Temperature measured in degrees Celsius from absolute zero,  $-273.18^{\circ}\text{C}$ . Absolute temperatures are given either as "degrees absolute" (e.g.,  $150^{\circ}\text{A}$ .) or as "degrees Kelvin" (e.g.,  $150^{\circ}\text{K}$ .).

**absorption** (ab-sorp'-tion) 1. Taking up, incorporation, or assimilation, as of liquids in solids or of gases in liquids. Cf: *adsorption*. 2. Reduction of the intensity of light in transmission through a substance or in reflection from a surface. In crystals, absorption may vary with the vibration direction of the transmitted light. Cf: *pleochroism*. 3. The process by which energy, such as that of electromagnetic or seismic waves, is converted into other forms of energy, e.g., heat. 4. The entrance of surface water into the lithosphere.

**absorption coefficient** The ratio of the energy absorbed by a material to that incident upon it. Syn: *absorptance*.

**abstraction** (ab-strac'-tion) 1. The

merging of two or more subparallel streams into a single stream course, as a result of competition between adjacent consequent gullies and ravines; the simplest type of stream capture. 2. That part of precipitation that does not become direct runoff, but is transpired, stored, evaporated, or absorbed.

**abundance** (a-bun'-dance) 1. The mean concentration of an element in a geochemical reservoir, e.g. the abundance of nickel in meteorites; also, relative average content, e.g. the order of abundance of elements in the earth's crust is O, Si, Al, etc. 2. The number of individuals of a particular taxon in a certain area or volume of sediment.

**abyssal** (a-byss'-al) 1. Pertaining to an igneous intrusion that occurs at considerable depth in the crust, or to the resulting rock; *plutonic*. 2. Pertaining to ocean depths of 4000 m or deeper, and to the organisms of that environment.

**abyssal hill** A relatively small topographic feature of the deep ocean floor, ranging to several hundred meters in height and several kilometers in diameter.

**abyssal plain** A flat region of the ocean floor, usually at the base of a continental rise, whose slope is less than 1:1000. It is formed by the deposition of turbidity-current and pelagic sediments that obscure the pre-existing topography.

**Acadian** (A-ca'-di-an) Middle Cambrian of North America. Ob-

solete syn. of *Albertan*.

**Acadian orogeny** A middle Paleozoic deformation, especially in the northern Appalachians. In Gaspé and adjacent areas, its climax is dated as early in the Late Devonian, but deformational, plutonic, and metamorphic events were prolonged over a more extended period. The Acadian had best be regarded, not as a single orogenic episode, but as an orogenic era.

Cf: *Antler orogeny*.

**acceleration** (ac-cel'-er-a'-tion)

During evolution, the appearance of modifications earlier and earlier in the life cycle of successive generations; adult characters of the ancestor appear earlier in immature stages of the descendants (*tachygenesis*), sometimes to the point that certain steps are omitted (*brachygenesis*).

**acceleration due to gravity** The acceleration of a body falling freely in a vacuum due to the gravitational attraction of the earth. The International Committee on Weights and Measures has adopted as a standard or accepted value  $980.665 \text{ cm/sec}^2$ , but its true value varies with latitude, altitude, and the nature of the underlying rocks.

**accelerometer** (ac-cel'-er-om'-o-ter)

An instrument used to measure acceleration; specifically, a seismograph designed to measure earth-particle accelerations.

**accessory element** (ac-ces'-so-ry) *trace element*.

**accessory mineral** A mineral whose presence in a rock is not

essential to the proper classification of the rock. Accessory minerals generally occur in minor amounts; in sedimentary rocks, they are mostly *heavy minerals*.

Cf: *essential mineral*.

**accidental inclusion** (ac-ci-den'-tal) *xenolith*.

**acclivity** (ac-cliv'-i-ty) An ascending slope, as opposed to *declivity*.

**accordant** (ac-cord'-ant) Matching or in agreement, e.g. said of two streams whose surfaces are at the same level at the place of junction, or said of several folds having similar orientation. Ant: *discordant*.

**accordant fold** One of several similarly oriented folds.

**accordant summit level** A hypothetical level or gently sloping surface that regionally intersects hilltops or mountain summits. In a region of high topographic relief, it suggests that the summits are remnants of a plain formed in a previous erosion cycle. See also: *summit concordance*.

**accreting plate boundary** (ac-cret'-ing) A boundary between two crustal plates that are moving apart, with new oceanic-type lithosphere being created at the seam. See also: *mid-oceanic ridge*.

Syn: *divergent plate boundary*.

**accretion** (ac-cre'-tion) 1. The gradual addition of new land to old by the deposition of sediment carried by the water of a stream.

2. The process by which inorganic bodies grow larger, by the addition of fresh material to the outside.

3. A theory of continental

growth by the addition of successive geosynclines to the craton.

**accretionary** (ac-cre'-tion-a-ry)

Tending to increase by external addition or accumulation, as a secondary sedimentary structure produced by overgrowth upon a pre-existing nucleus

**accretion hypothesis**

Any hypothesis of the origin of the earth which assumes that it has grown from a small nucleus by the gradual addition of solid bodies, such as meteorites, asteroids, or planetesimals, formerly revolving about the sun in independent orbits, but eventually drawn by gravitation to the earth and incorporated with it

**accretion ridge**

A beach ridge located inland from the modern beach, representing an ancient beach deposit and showing that the coast has been built seaward. It is often accentuated by the development of dunes

**accretion vein**

A type of vein in which the mineral deposit has been formed by repetition of channelway filling and reopening of the fractures.

**accumulation** (ac-cu'-mu-la'-tion)

1. All processes that add snow or ice to a glacier or to floating ice or snow cover, including snowfall, avalanching, and snow transport by wind. Cf: *ablation*. 2. The amount of snow and other solid precipitation added to a glacier or snowfield by the processes of accumulation.

**accumulation area**

The part of a glacier or snowfield in which,

over a year's time, accumulation exceeds ablation. Syn: *firm field*.

**ACF diagram**

A triangular diagram showing the simplified compositional character of metamorphic rocks and minerals by plotting the molecular quantities of the three components:  $A = \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3 - (\text{Na}_2\text{O} + \text{K}_2\text{O})$ ;  $C = \text{CaO} - 3.3\text{P}_2\text{O}_5$ ; and  $F = \text{FeO} + \text{MgO} + \text{MnO}$ .  $A + C + F$  (in mols) are recalculated to 100%; the presence of excess  $\text{SiO}_2$  is assumed. Cf: *AFM diagram*, *A'KF diagram*.

**ac-fracture**

In deformed rocks, a tension fracture parallel with the *ac-plane* and normal to *b*. Where ac-fractures are well developed, *b* is usually a strong lineation coincident with fold axes.

**achondrite** (a-chon'-drite)

A rare stony meteorite without *chondrules*. Achondrites represent meteorites that are most like terrestrial rocks. Adj: *achondritic*.

**acicular** (a-cic'-u-lar)

Needle-shaped, like certain crystals. Also, said of sedimentary particles more than three times as long as wide.

**acid** adj. 1. *acidic*. 2. Said of a plagioclase that is *sodic*.

**acidic** (a-cid'-ic) 1. A descriptive term applied to those igneous rocks that contain more than 60%  $\text{SiO}_2$ , as contrasted with *intermediate* and *basic*. Sometimes loosely and incorrectly used as equivalent to *felsic* and to over-saturated, but these terms include rock types (e.g., nepheline syenite, and quartz basalt, respectively)



that are not generally considered acidic. 2. Applied loosely to any igneous rock composed predominantly of light-colored minerals having a relatively low specific gravity. Syn. *acid; silicic*. 3. Less frequently used in reference to composition of feldspars, based on their content of silica. 4. When referring to hydrothermal, pegmatitic, or other aqueous fluids the term is used in its chemical sense of high hydrogen-ion concentration (low pH). 5. In furnace practice, said of a slag in which silica is present in excess of the amount required to form a "neutral" slag with the earthy bases present.

**acidization** (ac-id-i-zā-shun) The process of forming acid into a lime-stone, dolomite, or sandstone in order to increase permeability and porosity by removing a part of the rock constituents. It is also used to remove mud injected during drilling. The general objective of acidization is to increase productivity. Syn. *acid treatment*.

**acid mine drainage** Drainage with a pH of 2.0 to 4.5 from mines and mine wastes. It results from the oxidation of sulfides exposed during mining, which produces sulfuric acid and sulfate salts. The acid dissolves minerals in the rocks, further degrading the quality of the drainage water.

**ac-joint** A *cross joint* in folded rocks that is perpendicular to the fold axis.

**aclinic** (ac-clin'-ic) *magnetic equ*

**acme-zone** A *biozone* consisting of a body of strata representing the maximum abundance or frequency of occurrence of some species, genus, or other taxon. The corresponding geologic-time unit is *hemera*. Cf. *assemblage-zone; range-zone*. Syn. *epibole; peak-zone*.

**acmite** (ac'-mite) A brown or green mineral of the clinopyroxene group:  $\text{NaFe}(\text{SiO}_3)_2$ . It occurs in certain alkali rich igneous rocks. Syn. *aegirine*.

**acoustical well logging** (a-cous'-ti-cal) Any determination of the physical properties of a borehole by acoustical means. Travel times of P-waves over a unit distance are usually measured to determine velocities of surrounding rocks.

**acoustic log** (a-cous'-tic) Generic term for a *well log* that displays any of several measurements of acoustic waves in rocks exposed in a borehole, e.g. compressional-wave transit time over an interval (*sonic log*).

**acoustic wave** A longitudinal wave. In common usage it is restricted to fluids such as air, but it often includes P-waves in the solid earth.

**ac-plane** *d-deformation plane*.

**acquired character** A character not inherited but acquired by an individual organism during its lifetime as a result of use or disuse according to its mode of life or the conditions under which it lived.

**acre** A measure of surficial land area in the United States and Eng-

land, containing 43,560 square feet. It is based on an old unit thought to be equal to the amount of land that could be plowed by a yoke of oxen in a day. It is equivalent to 0.405 hectare.

**acre-foot** The volume of liquid or solid required to cover 1 acre to a depth of 1 foot, or 43,560 cubic feet. It is commonly used in measuring volumes of water, reservoir storage space, or reservoir rock.

**acre-yield** The average amount of oil, gas, or water recovered from 1 acre of a reservoir.

**acritarch** (ac'-ri-tarch) An apparently unicellular, resistant-walled microscopic organic body of unknown or uncertain biologic relationship and characterized by varied sculpture, some being spiny and others smooth. Many if not most acritarchs are of algal affinity, but the group is artificial. They range from Precambrian to Holocene, but are esp. abundant in Precambrian and early Paleozoic.

**actinolite** (ac-tin'-o-lite) A bright-green or grayish-green monoclinic mineral of the amphibole group:  $\text{Ca}_2(\text{Mg,Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$ . It occurs in slender needlelike crystals and in fibrous form in metamorphic rocks.

**activation** (ac-ti-va'-tion) 1. The process of treating bentonitic clay with acid to improve its adsorptive properties or to enhance its bleaching action. 2. The process of making a substance radioactive by bombarding it with nuclear particles.

**activation analysis** A method of

identifying stable isotopes of elements in a sample by irradiating the sample with neutrons, charged particles, or gamma rays to render the elements radioactive, after which the elements are identified by their characteristic radiations.

**activation energy** The extra amount of energy which any particle or group of particles must have in order to go from one energy state into another, such as changes in phase, as in chemical reactions, and movement of particles, as in diffusion.

**active fault** A fault along which there is recurrent movement which is usually indicated by small, periodic displacements or seismic activity. Cf. *capable fault*.

**active glacier** 1. A glacier that has an accumulation area and in which the ice is flowing. Ant. *dead glacier*. 2. A glacier that moves at a comparatively rapid rate.

**active layer** 1. A surface layer of ground, above the permafrost, that is alternately frozen in the winter and thawed in the summer. It is several centimeters to a few meters in thickness. 2. In engineering geology, surficial material that undergoes seasonal changes of volume, swelling when wet or frozen and shrinking when dry or thawing.

**active permafrost** Permafrost that is able to revert to a perennially frozen state under present climatic conditions after having been thawed by natural or artificial

means

**active volcano** A volcano that is erupting or is expected to erupt. There is no precise distinction between an active and a *dormant volcano*.

**activity ratio** (ac-tiv'-i-ty) The ratio of the *plasticity index* to the percentage of clay-sized minerals in sediment.

**acute bisectrix** (a-cute' bi-sect'-i-trix) In optically biaxial minerals, the line bisecting the acute angle between optical axes.

**adamantine luster** (ad-a-man'-ine) A brilliant mineral luster, characteristic of minerals with a high *index of refraction*, e.g. diamond and enstatite.

**adamelite** (ad-a-mel'-lite) *quartz monzonite*.

**adaptation** (ad-ap-ta'-tion) Modification as the result of natural selection of an organism or of its parts so that it becomes better fitted to exist under the conditions of its environment.

**adaptive norm** (a-dap'-tive) That part of an organic population that can survive and reproduce in the environment usually occupied by the species; the remainder may carry hereditary defects and diseases.

**adaptive radiation** Subdivision of a group of organisms into diversified groups within a short interval of geologic time, as a result of evolution. Equivalent niches in comparable habitats may be occupied by superficially similar but taxonomically distinct organisms. See also *explosive radiation*. Syn

*divergence*

**adductor muscle** (ad'-duc-tor) A muscle, or one of a pair of muscles that contracts and thereby closes and/or tends to hold together the valves of a bivalve shell (as in ostracodes, brachiopods, and pelecypods). Cf. *diductor muscle*.

**adhesion** (ad-he'-sion) The molecular attraction between contiguous surfaces. Cf. *cohesion*.

**adiabatic** (ad-i-a-bat'-ic) Pertaining to the relationship of pressure and volume when a gas or other fluid is compressed or expanded without either giving off or receiving heat.

**adit** A horizontal passage from the surface into a mine. It is commonly called a tunnel, though in strict usage a tunnel is open at both ends. Also called a drift or adit level.

**adjusted stream** A stream that flows essentially parallel to the strike of the underlying beds.

**adobe** (a-doh'-be) A mixture of clay and sand found in the desert basins of southwestern United States and in Mexico. The material is extensively used for making sun-dried bricks.

**adolescence** (ad-o-les'-cence) A stage following youth and preceding maturity in a developmental sequence such as the cycle of erosion. It is sometimes considered "early maturity." It may be applied wherever the terms youth and maturity are appropriate, e.g. in the regional erosion cycle, the karst cycle, or development of a

valley.

**adoral** (ad-o'-ral) Located or directed toward or near the mouth of an invertebrate. Cf. *aboral*.

**adsorption** (ad-sorp'-tion) Adhesion of gas molecules, or of ions or molecules in solution, to the surface of solid bodies with which they are in contact. Cf. *absorption*.

**adularia** (ad-u lar'-i-a) A moderate to low-temperature mineral of the alkali feldspar group.

**advance** 1 A continuing seaward movement of a shoreline, as a result of progradation or emergence, also net seaward movement, during a specified time period. 2 The forward movement of a glacier front, also, the time interval marked by such a forward movement. Ant. *retrocession*.

**advection** (ad-ver'-tion) 1 Horizontal transport of air or of an atmospheric property within the earth's atmosphere. 2 The horizontal or vertical flow of sea water as a current. 3 Lateral mass movement of mantle material — Cf. *convection*.

**aegirine** (ae'-gir-ine) A syn of *acmite*. The term is sometimes applied to acmite containing calcium, magnesium, or aluminum. Syn. *aegirite*.

**aegirite** (ae'-gir-ite) *aegirine*.

**aerate** (ae'-aie) To supply or charge with air.

**aeration** (ae-a'-tion) The supplying of air to the pores in a soil, or to waste water in a treatment plant.

**serial** (ae'r'-i-al) Pertaining to the

air; related to, located in, or consisting of, the earth's atmosphere. Not to be confused with *areal*.

**aerial magnetometer** *airborne magnetometer*.

**aerial photograph** A photograph of the earth's surface taken from the air. It is usually one of a series taken from an aircraft moving in a systematic pattern at a given altitude in order to obtain a mosaic for mapping land divisions, geology, soil, vegetation, topography, etc.

**aerobic** (ae-r-o'-bic) Said of organisms (esp. bacterial activities, and conditions) that can exist only in the presence of free oxygen. Cf. *anaerobic*.

**aerolite** (ae'r'-o-lite) *stony meteorite*.

**aeromagnetic** (ae'-o-mag-net'-ic) Pertaining to observations made with an *airborne magnetometer*.

**aerosol** (ae'r'-o-sol) A sol in which the dispersion medium is a gas (usually air) and the dispersed or colloidal phase consists of solid particles or liquid droplets, e.g. mist, haze, smog, smoke, and some fog.

**aerospace** (ae'r'-o-space) A mnemonic term derived from *aeronautics* + *space* to denote both the earth's atmosphere and the space beyond as a single unit.

**aff.** Abbrev. of *affinity*. It implies less certain similarity than does *cf.*

**affine** (af'-fine) Said of a homogeneous deformation, i.e. one in which initially straight lines remain straight after deformation.

**Affine transformation** is a mathematical transformation in which the coordinates of the deformed state are related to the coordinates of the undeformed state in a linear manner.

**affinity** (af-fin'-i-ty) In biology, the state of being akin to; used to indicate relationship without specifying identity. Abbrev: aff.

**AFM diagram** A triangular diagram showing the simplified compositional character of a metamorphosed pelitic rock by plotting molecular quantities of the three components:  $A = Al_2O_3$ ;  $F = FeO$ ; and  $M = MgO$ . Cf: *ACF diagram*; *A' KF diagram*.

**aftershock** An earthquake that follows a larger earthquake and originates at or near the focus of the latter. Many aftershocks may follow a major earthquake; they decrease in frequency and magnitude with time. Cf: *foreshock*.

**Aftonian** (Af-ton'-i-an) Pertaining to the classical first interglacial stage of the Pleistocene Epoch in North America, following the Nebraskan and preceding the Kansan glacial stages.

**agate** A translucent cryptocrystalline variety of quartz, being a variegated *chalcedony* frequently mixed or alternating with opal, and characterized by colors arranged in alternating stripes or bands, in irregular clouds, or in mosslike forms. Agate is found in vugs in volcanic rocks and in cavities in some other rocks. Cf: *onyx*; *moss agate*.

**age 1.** A unit of geologic time

shorter than an epoch and longer than a subage, during which the rocks of a *stage* were formed. 2. An informal term for a length of geologic time during which the rocks of any stratigraphic unit were formed. 3. A division of earth history of unspecified duration, marked by a dominant or important life form, as the "age of fishes". 4. The time during which a particular event or series of events occurred, or one that was marked by special physical conditions, e.g. the "Ice Age". 5. The position of anything in the geologic time scale, e.g. "rocks of Miocene age".

**age equation** The relationship between radioactive decay and geologic time. Expressed mathematically, it is  $t = 1/\lambda \ln(1 + D/P)$ , where  $t$  is the age of a rock or mineral specimen,  $D$  is the number of radiogenic daughter isotopes today,  $P$  is the number of parent isotopes today,  $\ln$  is the natural logarithm (logarithm to base  $e$ ), and  $\lambda$  is the decay constant. Cf: *general age equation*.

**age of amphibians** An informal designation of the late Paleozoic, i.e., the *Carboniferous* and the *Permian*.

**age of fishes** An informal designation of the *Silurian* and the *Devonian*.

**age of mammals** An informal designation of the *Cenozoic*.

**age of marine invertebrates** An informal designation of the *Cambrian* and the *Ordovician*.

**age of reptiles** An informal designation of the *Triassic* and the *Jurassic*.

nation of the *Mesozoic*.

**age ratio** The ratio of daughter to parent isotope, on which age is determined. For a valid age determination, the isotope system must have remained closed since solidification, metamorphism, or sedimentation, the decay constant must be known, and the sample must be truly representative of the rock from which it is taken.

**agglomerate** (ag-glom'-er-ate) A volcanic breccia formed by disruption of a solidified crust or hardened plug of lava. Blocks may fit together as a loose mosaic or be completely disordered.

**agglomerating** (ag-glom'-er-at-ing) Said of bituminous coal that softens when heated.

**agglutinate** (ag-glu'-ti-nase) n. 1 A welded pyroclastic deposit with glassy material binding the pyroclasts. 2. Certain particles in the lunar regolith that are held together and largely composed of glass.

**agglutinated** (ag-glu'-ti-nat-ed) Said of foraminifers whose tests are composed of minute pieces of substrate bound together by cement.

**aggradation** (ag'-gra-da'-tion) 1. The process of building up a surface by deposition. 2. The spread or growth of permafrost.—Ant: *degradation*.

**aggrading stream** (ag-grad'-ing) 1. A stream that is actively building up its channel or flood plain by being supplied with more load than it is capable of transporting. 2. A stream that is upbuilding ap-

proximately at *grade*.

**aggregate** (ag'-gre-gate) 1. A mass or body of rock particles, mineral grains, or both. 2. Any of several hard, inert materials, such as sand, gravel, slag, or crushed stone, used for mixing with a cementing or bituminous material to form concrete, mortar, or plaster; or used alone, as in railroad ballast or graded fill. See also: *coarse aggregate*; *fine aggregate*; *lightweight aggregate*.

**aggregate structure** A mass of separate little crystals, scales, or grains which extinguish under the polarizing microscope at different intervals during the rotation of the stage.

**aggressive intrusion** (ag-gres'-sive) *forcible intrusion*.

**aging** The process by which a young lake becomes an old lake as a result of filling and nutrient loading, *eutrophication*, vegetation encroachment, and other actions.

**Aganatha** (Ag-na'-tha) A class of vertebrates, the jawless fishes. A modern example is the lamprey. Range, Ordovician to the present.

**agonic line** (a-gon'-ic) A line passing through points on the earth's surface at which the direction of the magnetic needle is truly north and south; a line of no magnetic declination.

**A horizon** The uppermost zone in the soil profile, from which soluble salts and colloids have been leached, and in which organic matter has accumulated. Approx. syn: *topsoil*.

**airborne magnetometer** An instrument used to measure variations in the earth's magnetic field while being transported by an aircraft. Syn: *flying magnetometer*.

**air drilling** *Rotary drilling* using high-velocity air instead of conventional *drilling mud*. It is unsuitable where significant volumes of water may be encountered or where natural gas may create an explosive mixture.

**air gun** An energy source much used in marine seismic surveys. Air under high pressure is explosively released to generate the initial shock wave. Air guns have been adapted for use in borehole velocity surveys.

**air shooting** Applying a seismic pulse to the earth by detonating an explosive charge in the air above the surface; also, the process of exploration by the use of such detonations.

**air wave** The acoustic energy pulse transmitted through the air as a result of the detonation of a seismic shot.

**Airy hypothesis** A concept of equilibrium for the earth's solid outer crust in which the crustal density is assumed to be constant, so that mountains are compensated by "roots" analogous to the underwater extensions of icebergs floating in the ocean. See also: *Pratt hypothesis*; *isostasy*.

**A'KF diagram** A triangular diagram showing the simplified compositional character of a metamorphic rock by plotting molecular quantities of the three compo-

nents:  $A' = Al_2O_3 + Fe_2O_3 - (Na_2O + K_2O + CaO)$ ;  $K = K_2O$ ; and  $F = FeO + MgO + MnO$ .  $A' + K + F$  (in mols) are recalculated to 100%; the diagram is used in addition to the *ACF diagram* when K minerals require representation. Cf: *AFM diagram*.

**alabaster** (al'-a-bas-ter) A compact fine-grained gypsum, white or delicately shaded and often translucent. It is used for ornamental vessels, figures, and statuary.

**alaskite** (a-las'-kite) A plutonic rock consisting of oligoclase, microcline, and quartz, with subordinate muscovite and few or no mafic constituents. It is a commercial source of feldspar.

**alate** (a'-late) Having wings or a winged form; e.g. said of a brachiopod shell in which the valves are drawn out at the ends of the hinge line to form winglike extensions.

**A layer** The seismic region of the earth equivalent to the *crust*, extending from the surface to the Moho.ovičić discontinuity. It is part of a classification of the earth's interior made up of layers A to G.

**alb** Flat or gently inclined narrow shelf separating the nearly vertical side of an alpine glacial trough from the mountain slope above.

**albedo** (al-be'-do) The percentage of the incoming radiation that is reflected by a natural surface such as the ground, ice, snow, water, clouds, or particulates in the atmosphere.

**Albers projection** (Al'-bers) An

equal-area projection of the conical type, on which the meridians are straight lines that meet in a common point beyond the limits of the map and the parallels are concentric circles whose center is at the point of intersection of the meridians. Meridians and parallels intersect at right angles, and the arcs of longitude along any given parallel are of equal length. The parallels are spaced to retain the condition of equal area. Along two selected parallels, called standard parallels, the scale is held exact; along the other parallels it varies with latitude but is constant along any given parallel.

**Albertan** (Al-bert'-an) Middle Cambrian of North America. Obsolete syn: *Acadian*.

**albite** (al'-bite) 1. A white or colorless triclinic mineral of the feldspar group:  $\text{NaAlSi}_3\text{O}_8$ . It is a variety of plagioclase that occurs commonly in igneous and metamorphic rocks. 2. The pure sodium-feldspar end member in the plagioclase series.

**albite-epidote-amphibolite facies** The set of metamorphic mineral assemblages in which basic rocks are represented by hornblende + albite + epidote. It is thought to be produced under the higher pressures of regional metamorphism.

**albitite** (al'-bi-tite) A porphyritic igneous rock consisting almost wholly of albite phenocrysts in an albite groundmass. Common accessory minerals are muscovite, garnet, apatite, quartz, and

opaque oxides.

**Alexandrian** (Al-ex-an'-dri-an) Lower Silurian of North America. Obsolete syn: *Medinan*.

**alexandrite** (al'-ex-an'-drite) A transparent variety of chrysoberyl that has a grass-green or emerald-green color in daylight and wine-red to brownish-red color by transmitted or incandescent artificial light. Used as a gem and a birthstone for June.

**algae** Photosynthetic, almost exclusively aquatic plants of a large and diverse group (the Algae), including seaweeds and their freshwater allies. They range in size from simple unicellular forms to giant kelps several meters long, and display extremely varied life-cycles and physiological processes, with, for example, different complexes of photosynthetic pigments. Algae range from the Precambrian. An individual plant is called an *alga*.

**algal** (al'-gal) Of, pertaining to, or composed of algae.

**algal biscuit** Any of various hemispherical or disk-shaped calcareous masses, up to 20 cm in diameter, produced in fresh water as a result of precipitation by various blue-green algae.

**algal bloom** A proliferation of living algae on the surface of lakes, streams, or ponds. Algal blooms are stimulated by enrichment in phosphates or other nutrients.

**algal limestone** A limestone composed largely of the remains of calcium-carbonate-producing algae, or one in which such algae



serve to bind together the fragments of other calcium-carbonate producers.

**algal structure** A calcareous sedimentary structure secreted and precipitated by colonial algae. It includes crusts, pseudoconcretions, biscuit- or cabbage-like bodies, and laminated masses such as stromatolites

**Algonian orogeny** (Al-go'-man) Orogeny and accompanying granitic emplacement that affected Precambrian rocks of northern Minnesota and adjacent Ontario about 2400 m.y. ago. It is synonymous with the Kenoran orogeny of the Canadian Shield

**Algonkian** (Al-gon'-ki-an) *Proterozoic*.

**alidade** (al'-i-dade) A straight-edge rule equipped with simple or telescopic sights, used for determining direction, distance, and angle of elevation. It commonly consists of a telescope with index and reading or recording accessories, and is the surveying instrument used with a plane table for mapping. See also: *Gale alidade*

**alkali** (al'-ka-li) *n.* 1. Sodium carbonate or potassium carbonate, or more generally any bitter-tasting salt found at or near the surface in arid and semiarid regions. 2. A strong base, e.g., NaOH or KOH. 3. Loosely, compounds of sodium and potassium, as the *alkali* in glass.—*adj.* Rich in sodium or potassium, as *alkali feldspar*.

**alkali-calcic series** Those igneous rock series having alkali-lime in-

dices in the range 51-55.

**alkalic igneous rocks** (al'-ka-lic)

Those igneous rocks that (a) contain more sodium and potassium than is average for the group of rocks to which they belong, or than is required to form feldspar with the available silica; (b) have an *alkali-lime index* below 51; or (c) belong to the *Atlantic suite*.

**alkali feldspar** Sodium- or potassium-rich feldspar, e.g. microcline, orthoclase, albite, anorthoclase, or sanidine.

**alkali flat** A level area or plain in an arid or semiarid region, encrusted with alkali salts that became concentrated by evaporation and poor drainage; a *salt flat*. See also: *playa*.

**alkali lake** A *salt lake*, commonly found in an arid region, whose waters contain in solution large amounts of sodium carbonate and potassium carbonate, as well as sodium chloride and other alkaline compounds; e.g. Lake Magadi in the Eastern Rift Valley of Kenya. See also: *soda lake*.

**alkali-lime index** The weight percentage of silica, in a sequence of igneous rocks on a variation diagram, where the weight percentages of CaO and of ( $K_2O + Na_2O$ ) are equal, i.e., the point of crossing of the curves for CaO and ( $K_2O + Na_2O$ ).

**alkali metal** Any metal of the alkali group, as lithium, sodium, potassium, rubidium, or cesium.

**alkaline** (al'-ka-line) 1. Having the qualities of a base; *basic*. 2. Sometimes applied to igneous rocks in

preference to *alkali*.

**alkalinity** (al-ka-lin'-i-ty) 1 The quantity and kinds of compounds present in a lake that collectively shift the pH to the alkaline side of neutrality. 2 The number of milliequivalents of hydrogen ion that is neutralized by one liter of sea water at 20°C.

**Alkemade line** (Al-ke-mayd) In a ternary phase diagram, a straight line that connects the composition points of two primary phases whose areas are adjacent. It shows a line of solus boundaries.

**Alleghenian** (Al'-i-ghen-ee-an) Lower-Middle Pennsylvanian, eastern North America.

**Allegheny orogeny** (Al'-i-ghen-ee-or-oh-jen-ee) A mountain-building event that deformed the rocks of the Valley and Ridge province and those of the adjacent Appalachian Plateau in the central and southern Appalachians. Most of the orogeny was probably later in the Paleozoic, but phases may have extended into the early Triassic.

**alliacious** (al'-i-see-ohs) Applied to minerals having the odor of garlic when rubbed or heated, e.g., pyrite minerals.

**Alling grade scale** A metric scale of grain size for two-dimensional measurements (as with thin sections or polished blocks) of sedimentary rocks. It has a constant geometric ratio of 10 for the major divisions (colloid, clay, silt, sand, gravel, cobble, boulder) and a ratio of the fourth root of 10 for the four-fold subdivisions of each

major unit.

**allochem** (al-'to-chem) One of the carbonate aggregates that serve as the framework grains in most mechanically deposited limestone, e.g., silt, sand- and gravel-size *intraclasts*, oolitic pebbles, and fossil shell fragments.

**allochemical metamorphism** (al-'lo-chem-i-cal) Metamorphism accompanied by addition or removal of material so that the bulk chemical composition of the rock changed.

**allochthon** (al-'lo-thon) A mass of rock that has been moved a long distance from its place of origin, commonly as a result of processes such as subducting, perhaps gravity, from a *catenoclithon*.

**allochthonous** (al-'lo-thon-ohs) Said of rocks or materials that elsewhere than in their places of place of origin, e.g., Ant. 2, *Extraneous*.

**allogene** (al-'lo-jen-ee) An *allogenic* mineral or rock constituent, e.g., a xenolith in an igneous rock, a pebble in a conglomerate, or a detrital mineral in a placer deposit.

**allogenic** (al-'lo-jen-'ic) 1 Generated elsewhere. The term applies to rocks or minerals that came into existence outside of, and previously to the rock of which they now constitute a part, e.g., the pebbles of a conglomerate. Ant. *authigenic*. 2 Said of an ecologic succession that resulted from factors that arise from outside the natural community and alter its habitat. Cf. *autogenic*.

**allophane** (al-lo-phane) An amorphous clay mineral, a hydrous aluminosilicate gel of highly variable composition.

**allotriomorphic** (al-lot-ri-morphic) *xenomorphic*.

**allotropic** (al-lo-trop'-ic) Said of substances that may exist in two or more forms, as diamond and graphite.

**allowable** (al-low'-a-ble) The amount of oil or gas that a well or leasehold is permitted to produce under *proration* by a regulatory body.

**alluvial** (al-lu-vi-al) 1 Pertaining to or composed of alluvium or deposited by a stream or running water. 2 Said of a *placer* formed by the action of running water, as in a stream channel or alluvial fan; also, said of the valuable mineral, e.g. gold or diamond associated with an alluvial placer.

**alluvial dam** A sedimentary deposit built by an overloaded stream which dams its channel, especially characteristic of distributaries on alluvial fans.

**alluvial fan** An outspread, gently sloping mass of alluvium deposited by a stream, esp. in an arid or semiarid region where a stream issues from a narrow canyon onto a plain or valley floor. Viewed from above, it has the shape of an open fan, the apex being at the valley mouth. Cf. *bajada*.

**alluvial plain** A plain produced by deposition of alluvium, e.g. a delta plain, flood plain, alluvial fan, or *bajada*.

**alluviation** (al-lu-vi-a'-tion) The

deposition of alluvium along stream courses, *aggradation*. Also, the covering or filling of a surface with alluvium.

**alluvium** (al-lu'-vi-um) A general term for detrital deposits made by streams on river beds, flood plains, and alluvial fans, esp. a deposit of silt or silty clay laid down during time of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas and lakes.

**almandine** (al-man-dine [al'-man-deen]) The iron-aluminum end member of the garnet group characterized by a deep-red to purplish color.  $\text{Fe}_3\text{Al}_2(\text{SiO}_4)_3$ . It occurs in mica schists and other regionally metamorphosed rocks and is used as a gemstone. Syn. *almandite*.

**alpine** 1 A high rugged, steep-sided mountain, esp. one that is snow-covered resembling those in the European Alps. 2 A high pasture or meadowland on a mountain side, between timberline and snowline, like those in the Swiss Alps. 3 An *alb*.

**alpha particle** 1 A particle, emitted from an atomic nucleus during one type of radioactive decay, which is positively charged and has two protons and two neutrons. It is physically identical with the nucleus of a  $^4\text{He}$  atom. Cf. *beta particle*, *gamma radiation*. 2 By extension, the nucleus of a  $^4\text{He}$  atom.—Less preferred syn. *alpha ray*.

**alpha quartz** The polymorph of

quartz that is stable below 573°C and that has a higher refractive index and birefringence than *beta quartz*. It occurs commonly in igneous, metamorphic, and sedimentary rocks, and in veins, geodes, and large pegmatites. Also spelled:  $\alpha$ -quartz. Syn: *low quartz*.

**Alpides** (Al'-pi-des) The great east-west orogenic belt that includes the Alps of Europe and the Himalayas and related mountains of Asia

**alpine** (al'-pine) 1. Of or pertaining to the European Alps or any lofty mountain system, esp. if modified by intense glacial erosion. 2. A general term for topographic and structural features that resemble in grandeur and complexity those of the European Alps.

**alpine glacier** A glacier in mountainous terrain. It generally originates in a *cirque* and may flow down a valley previously made by a stream. Syn: *mountain glacier*; *valley glacier*.

**Alpine orogeny** A name for the relatively young orogenic events of southern Europe and Asia, by which the rocks of the Alps and the remainder of the Alpidic orogenic belt were strongly deformed. Most geologists restrict the era to the Tertiary, with many episodes of varying strength from place to place, ending during the Miocene or Pliocene.

**alteration** (al-ter-a'-tion) Changes in the chemical or mineralogical composition of a rock, generally produced by weathering or hy-

drothermal solutions.

**alternation of generations** (al-ter-na'-tion) The orderly succession of asexual and sexual types of reproduction in the life cycle of a plant or animal.

**altimeter** (al-tim'-e-ter) An aneroid barometer used for determining elevations.

**altiplanation** (al'-ti-pla-na'-tion) *Solifluction* and related mass movements that tend to produce flat or terracelike surfaces, esp. at high elevations and latitudes where periglacial processes predominate. Cf: *cryoplanation*; *equiplanation*.

**altiplano** (al-ti-pla'-no) A high-lying plateau or tableland; specif. the high plateau of western Bolivia, consisting of a string of intermontane basins. Etymol: Spanish.

**altithermal** (al-ti-ther'-mal) n. A period of high temperature, esp. the postglacial thermal optimum.—adj. Pertaining to a climate of rising or high temperatures.

**altitude** (al'-ti-tude) 1. The vertical angle between the plane of the horizon and a line to any higher point, such as the top of a peak. 2. The vertical distance between a point and a datum surface, generally mean sea level. See also: *elevation*.

**alum** 1. A mineral:  $KAl(SO_4)_2 \cdot 12H_2O$ . It is colorless or white, and has a sweet-sour astringent taste. 2. A group of minerals containing hydrous aluminum sulfates, including alum, kalinite,

soda alum, mendozite, and tschermugite.

**alumina** (a-lu'-mi-na) Aluminum oxide,  $Al_2O_3$

**alum shale** An argillaceous, often carbonaceous, rock impregnated with *alum*, originally containing iron sulfide (pyrite, marcasite) which, when decomposed, formed sulfuric acid that reacted with the aluminous and potassic materials of the rock to produce aluminum sulfates

**alunite** (al'-u-nite) A mineral,  $KAl_3(SO_4)_2(OH)_6$ , rhombohedral. It is usually in white, gray, or pink masses in hydrothermally altered feldspathic rocks

**alunization** (al-u'-nit-i-za'-tion) Introduction of, or replacement by, alunite

**alveolar** (al ve-o'-lar) 1 In invertebrates, having small cavities or pits 2 In vertebrates, pertaining to a tooth socket

**amalgam** (a mal'-gam) 1 A naturally occurring alloy of silver and mercury 2 An alloy of mercury with another metal, esp. gold

**amazonite** (am'-a-zon-ite) A green or blue-green variety of microcline, sometimes used as a gemstone. Syn *amazonstone*.

**amazonstone** (am'-a-zon-stone) *amazonite*.

**amber** A fossil resin from coniferous trees. It is usually yellow or brown and transparent, may enclose insects and other organisms, and takes a polish. It is found in alluvial soils and lignite beds, and on some seashores, esp. of the Baltic Sea.

**amblygonite** (am-blyg'-o-nite) A mineral  $(Li,Na)Al(PO_4)(F,OH)$ . Triclinic. An ore of lithium, found in pegmatites as white or greenish cleavable masses

**amethyst** (am'-e-thyst) A purple or bluish-violet variety of quartz,  $SiO_2$ . Used as a gem, and a birthstone for February

**ammonite** (am'-mo-nite) Any ammonoid belonging to the order Ammonitida, characterized by a thick, strongly ornamented shell with sutures having finely divided lobes and saddles. Range, Ordovician to Cretaceous

**ammonoid** (am'-mo-noid) Any extinct cephalopod belonging to the subclass Ammonoidea, characterized by an external shell that is symmetrical and coiled in a plane and has a bulbous protoconch, septa that form angular sutural flexures, and a small marginal siphuncle. Range, Lower Devonian to Upper Cretaceous. The subclass includes the *ammonites*, *ceratites*, and *goniatites*.

**amniote** (am'-ni-ote) adj. Pertaining to a vertebrate egg characterized by a large yolk and covered by a shell which is lined with cellular membranes produced from embryonic tissue, which function to conserve water and for the exchange of gases —n Any vertebrate reproducing by means of such an egg, the term includes all tetrapod classes except the amphibians

**amorphous** (a-mor'-phous) Literally without form, applied to rocks and minerals having no definite

crystalline structure. Ant. *crystalline*.

**amorphous graphite** Very fine-grained, generally sooty graphite from metamorphosed coal beds.

The word "amorphous" is a misnomer, as all graphite is crystalline. The term has also been applied to very fine particles of *flake graphite* that can be sold only for low-value uses (such as foundry facings) and to fine-grained varieties of Ceylon lump graphite.

**amosite** (am'-o-site) A commercial term for an iron-rich asbestiform variety of amphibole occurring in long fibers. It may consist of an orthorhombic amphibole (anthophyllite or gedrite) or of a monoclinic amphibole (cumingtonite or grunerite).

**amphibian** (am-phi'b'-i-an) A cold-blooded four-footed animal that breathes by means of gills in the early stages of life and by means of lungs in the later stages. It develops from a larval tadpole stage. Examples: frogs, toads, newts, and salamanders.

**amphibole** (am-phi-hole) A mineral group with the general formula  $A_2B_6(Si,Al)_8O_{22}(OH)_2$ , where A is mainly Mg, Fe, Ca, or Na, and B is mainly Mg, Fe<sup>+2</sup>, Al, and Fe<sup>+3</sup>. It includes common rock-forming minerals characterized by good prismatic cleavage in two directions intersecting at angles of 56° and 124°. The most common amphibole minerals are hornblende, tremolite-actinolite, and cumingtonite-grunerite.

**amphibolite** (am-phi'b'-o-lite) A

crystalloblastic rock consisting mainly of amphibole and plagioclase with little or no quartz. As the content of quartz increases, the rock grades into hornblende-plagioclase gneiss.

**amphibolite facies** The set of metamorphic mineral assemblages in which basic rocks are represented by hornblende + plagioclase, the latter being oligoclase-andesine or a more calcic variety. The facies is typical of regional metamorphism under moderate to high pressures and temperatures. Cf. *albite-epidote-amphibolite facies*.

**amphineuran** (am-phi-neu'-ran) A marine mollusk belonging to the class Amphineura, with a flattened body covered by eight articulated dorsal plates. A common form is the chiton.

**amphoteric** (am-pho-ter'-ic) Having both basic and acidic properties.

**amplitude** (ain'-pu-tude) 1. Half the height of the crest of a wave or ripple above the adjacent troughs. 2. In a symmetrical fold, half the orthogonal distance between antiformal crest and synformal trough.

**amygdale** (a-myg'-dale) *amygdule*.

**amygdaloid** (a-myg'-da-loid) A general name for a volcanic rock (ordinarily basalt or andesite) that contains numerous amygdules. Adj. *amygdaloidal*.

**amygdule** (a-myg'-dule) A gas cavity or vesicle in an igneous rock which is filled with such secondary minerals as zeolites, calcite, quartz, or chalcedony. The

term amygdale is preferred in British usage

**anaerobic** (an-ae-o'bi-adj) 1 Said of organisms (esp. bacteria) that can live in the absence of free oxygen. Also said of their activities. — Noun: *anaerobe*. 2 Said of conditions that exist or live in the absence of free oxygen. (Cf. *aerobic*.)

**anaerobic sediment** 3 Light or gray sediment characteristic of basins where restricted circulation of the water results in the absence of near a source of oxygen at the sediment surface, and bottom water is rich in hydrogen sulfide. *anoxic* (a-nak-adj) (See *anoxic*.)

**analcime** (a-nal-sim [a-na-seem]) 4 Mineral,  $\text{NaAlSi}_2\text{O}_6 \cdot \text{H}_2\text{O}$ . It is an isometric zeolite, commonly found in diabase and in alkali-rich basalts. Syn: *analcite*. **analog** (an'a-log) Said of any device that represents a range of numbers by directly measurable quantities, such as voltage or rotation, as in an analog computer or a analog system. (Cf. *digital*.)

**analytic group** (an-a-lyt-ik) A rock stratigraphic unit formerly classed as a formation but now called a *group* because subdivisions of the unit are considered to be formations. (Cf. *synthetic group*.)

**analyzer** (an'a-lay-zer) The polarizing medium in a petrographic microscope that intersects the light after it has passed through the *polarizer* and the object under study. See *Nicol prism*.

**anamorphism** (an-a-mor-'phizm) Intense metamorphism in which

rock flowage takes place and simple minerals of low density are changed into more complex ones of greater density by silication, decarbonization, dehydration, and deoxidation. Cf. *katamorphism*.

**anastomosing** (a-nas'-to-mos-ing) 1 Branching and recombining, as in a *braided stream*. 2 Interwoven, said of leaves whose veins form a netlike pattern.

**anatase** (an-a-tase) A mineral,  $\text{TiO}_2$ , is trimorphous with rutile and brookite. Syn: *octahedrite*.

**anatexis** (an-a-tex-iss) Melting of pre-existing rock. The term is commonly modified by terms such as *intergranular*, *partial differential*, *selective*, or *complete*. (Cf. *syntexis*.)

**anatexite** (an-a-tex'-ite) Rock formed by anatexis. Also spelled *anatectite*. See also *syntectite*. (Cf. *arterite*.)

**anaukite** (an-aux'-ite) A clay consisting of a mixture of kaolinite and amorphous silica.

**anchored dune** A sand dune stabilized by growth of vegetation. Syn: *stabilized dune*.

**anchor ice** (an'cho-ice) Spongy undrained water ice formed on a submerged object or structure, or attached to the bottom of a shallow body of water which itself is not frozen. Syn: *bottom ice*.

**andalusite** (an-da-lu'-site) A mineral,  $\text{Al}_2\text{SiO}_5$ , trimorphous with kyanite and sillimanite. Orthorhombic. It commonly occurs in thick, nearly square prisms in schists and gneisses.

**andesine** (an'-de-sine) A mineral of the plagioclase feldspar group with composition ranging from  $Ab_{70}An_{30}$  to  $Ab_{50}An_{50}$ . It occurs as a primary constituent of intermediate igneous rocks such as andesites and diorites.

**andesite** (an'-de-site) A dark colored, fine-grained extrusive rock that, when porphyritic, contains phenocrysts composed primarily of zoned sodic plagioclase (esp. andesine) and one or more of the mafic minerals (e.g. biotite, hornblende, pyroxene) with a ground mass composed generally of the same minerals as the phenocrysts, the extrusive equivalent of *diorite*. Andesite grades into *latite* with increasing alkali feldspar content and into *dacite* with more alkali feldspar and quartz. It was named by Buch in 1826 from the Andes Mountains, South America.

**andesite line** The geographic petrographic boundary between basalts of the *Atlantic suite* and the mainly andesitic rocks of the *Pacific suite*. The boundary on the west is generally drawn from Alaska to the east of New Zealand and Chatham Island, by way of Japan, the Marianas, Palau Islands, Bismarck Archipelago, and the Fiji and Tonga groups. The boundary on the east is less clearly defined, but probably runs along the coasts of North and South America. It has not been traced in the South Pacific. *See Marshall line*.

**andradite** (an'-dra-date) The calc-

ium-iron end member of the garnet group,  $Ca_3Fe_2(SiO_4)_3$ . It is common in contact-metamorphosed limestones.

**aneroid barometer** (an'-er-oid) An instrument that measures change of atmospheric pressure by its effect on the thin sides of a partially evacuated short hollow cylinder. It is commonly used to measure altitude. The *altimeter* is a barometer of this type. Cf. *mercury barometer*.

**Angaraland** (An-gar'-a land) A small shield exposing Precambrian rocks in north-central Siberia, once supposed to have been the nucleus around which all other structures of Asia were built. Modern Soviet geologists ascribe less significance to the feature.

**angiosperm** (an'-gi-o-sperm) A plant with true flowers in which the seeds, resulting from double fertilization, are enclosed in an ovary, comprising the fruit. Such plants originated in the Early Cretaceous or possibly before. Examples include grasses, orchids, elms, roses. Cf. *gymnosperm*. *Syn flowering plant*.

**angle of emergence** The angle formed between a ray of energy—optic, acoustic, or electromagnetic—and the horizontal. It is the complement of the *angle of incidence*.

**angle of incidence** The angle that a ray of energy—optic, acoustic, or electromagnetic—makes with the normal to a boundary surface. It is the complement of the *angle of emergence*. *See also critical an-*



*gle.*

**angle of repose** The maximum slope or angle at which loose, cohesionless material remains stable. It commonly ranges between 3° and 37° on natural slopes.

**anglesite** (an'-gle-site) A white orthorhombic mineral.  $\text{PbSO}_4$ . It is a common secondary mineral formed by the oxidation of galena and is a valuable ore of lead.

**Ångström unit** A unit of length,  $10^{-8}$  cm., commonly used in structural crystallography. Often anglicized to Angstrom, abbreviated Å or Å.

**angular** (an'-gu-lar) Having sharp angles or borders, specif. said of a sedimentary particle showing little or no evidence of abrasion, with all its edges and corners sharp. Also, said of the *roundness class* containing angular particles.

**angular cross-bedding** Cross-bedding in which the inclined beds appear in section as nearly straight lines meeting the underlying surface at high, sharp, or discordant angles; it often implies deposition by water, as in *torrential cross-bedding*. Cf. *tangential cross-bedding*.

**angularity** (an'-gu-lar'-i-ty) A term sometimes used for the property of a sedimentary particle now commonly known as *roundness*.

**angular unconformity** An *unconformity* in which younger sediments rest upon the eroded surface of tilted or folded older rocks. Cf. *disconformity*; *nonconformity*.

**anhedral** (an-he'-dral) Said of a mineral crystal showing no *rational faces*, or of a detrital grain that shows no crystal outline. Cf. *euhedral*; *subhedral*.

**anhydrite** (an-hy'-drite) A mineral, anhydrous calcium sulfate,  $\text{CaSO}_4$ . Orthorhombic, commonly massive in evaporite beds. It alters readily to gypsum.

**anhydrous** (an-hy'-drous) Completely or essentially without water, as an anhydrous magma or mineral.

**anion** (an'-i-on) An ion that bears a negative charge.

**anisometric** (an'-i-so-met'-ric) Said of crystals having unequal dimensions. Ant: *equant*.

**anisotropic** (an'-i-so-trop'-ic) Having some physical property that varies with direction. All crystals are anisotropic relative to some properties, unless otherwise stated, however, the term refers to optical properties. In this sense, all crystal, except those of the isometric system are anisotropic. Ant: *isotropic*.

**anisotropy** (an-i-sot'-ro-py) The condition of having different properties in different directions, as in geologic strata that transmit sound waves with different velocities in the vertical and horizontal directions. Adj: *anisotropic*.

**ankerite** (an'-ker-ite) A mineral, a ferroan variety of dolomite,  $\text{CaCO}_3 \cdot (\text{Mg}, \text{Fe}, \text{Mn})\text{CO}_3$ .

**annelid** (an'-ne-lid) Any wormlike invertebrate belonging to the phylum Annelida, characterized by a segmented body with a distinct

head and appendages. Because the annelids lack skeletal structures (except for chitinous jaws, called *scuticodonta*), they are usually known as fossils only from their burrows and trails.

**annual layer** 1. A sedimentary layer deposited or presumed to have been deposited during the course of a year, e.g. a glacial varve. 2. A dark layer (in a salt intrusion) containing formerly disseminated anhydrite that accumulated on solution of the enclosing salt.

**annual ring** The layer of xylem (wood) formed by one year's growth of cambium.

**annular drainage pattern** (an'-nu-lar) A stream pattern that is roughly circular or ringlike. It commonly forms during nature dissection of a structural dome or basin.

**annulus** (an'-nu-lus) The space between the casing in a well and the wall of the hole, or between two concentric strings of casing, or between casing and tubing.

**anomaly** (a-nom'-a-li) 1. A departure from the expected or normal. 2. In gravity surveying, the difference between an observed value and the corresponding computed value. 3. A geological feature, esp. in the subsurface, distinguished by geological, geophysical, or geochemical means, which is different from the general surroundings and is often of potential economic value, e.g. a magnetic anomaly.

**anorogenic** (an'-or-o-gen'-ic) Not related to tectonic disturbance,

crustally inactive.

**anorthite** (an-or'-thite) 1. A white or gray triclinic mineral of the feldspar group:  $\text{CaAl}_2\text{Si}_2\text{O}_8$ . It is the most calcic member of the plagioclase series, and occurs esp. in basic and ultrabasic igneous rocks. Syn. *calcium feldspar*. 2. The pure calcium-feldspar end member in the plagioclase series.

**anorthoclase** (an-or'-tho-clase) A triclinic mineral of the alkali feldspar group:  $(\text{Na},\text{K})\text{AlSi}_3\text{O}_8$ . It is a sodium-rich feldspar ( $\text{Or}_{40}\text{Ab}_{60}$  to  $\text{Or}_{10}\text{Ab}_{90}$ ) that shows deviations from monoclinic symmetry and that contains very fine-grained intergrowths of orthoclase.

**anorthosite** (an-or'-tho-nite) A plutonic rock composed almost wholly of plagioclase.

**antarctic** (ant-arn'-tic) n. The area within the Antarctic Circle, the region of the South Pole—adj. Pertaining to features, climate, vegetation, and animals characteristic of the antarctic region.

**antecedent stream** (an-te-ced'-ent) A stream that was established before local uplift began and incised its channel at the same rate the land was rising, a stream that existed prior to the present topography.

**antediluvian** (an'-te-di-lu'-vi-an) Produced before Noah's flood.

**anterior** (an-te'-ri-or) adj. Situated toward the front of an animal, or near or toward the head or head region, as opposed to *posterior*. — n. The forward-moving or head region of an animal.

**anthophyllite** (an-thoph'-yl-lite) A mineral of the amphibole group  $(\text{Mg,Fe})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$ . It is a variety of *asbestos*, normally occurring in metamorphic rocks as lamellae, radiations, or fibers.

**anthozoan** (an-tho-zo'-an) Any coelenterate belonging to the class Anthozoa which includes marine forms that build solitary or colonial calcareous external skeletons: the corals. Range, Ordovician to the present.

**anthracite** (an'-thra-cite) Coal of the highest metamorphic rank, in which fixed-carbon content is between 92% and 98% (on a dry mineral-matter-free basis). It is hard and black, and has a semi-metallic luster and semiconchoidal fracture. Anthracite ignites with difficulty and burns with a short blue flame, without smoke. Syn. *hura coal*.

**anthraxolite** (an-thrax'-o-lite) A hard, black *asphaltite* with a high fixed-carbon content. It occurs in veins and masses in sedimentary rocks, especially in association with oil shales.

**anthraxylon** (an-thra-xy'-lon [an-thra-zy'-lon]) A composite term for the vitreous coal components derived from woody tissues of plants and forming lustrous bands interlayered with dull *atritus* in banded coal. Etymol. Greek *anthrax*, "coal", and *xyton*, "wood".

**anticlinal** (an-ti-chi'-nal) Of or pertaining to an anticline.

**anticlinal axis** The line which, moved parallel to itself, generates

the form of an anticline.

**anticlinal theory** The theory that oil and gas tend to accumulate in anticlinal structures. It was well set forth by I. C. White in 1885.

**anticlinal valley** A valley that follows the axis of an anticline.

**anticline** (an'-ti-cline) A fold, generally convex upward, whose core contains the stratigraphically older rocks. Ant. *syncline*. See also *antiform*.

**anticlinorium** (an'-ti-chi-no'-ri-um) A composite anticlinal structure of regional extent composed of lesser folds. Cf. *synclinorium*. Pl. *anticlinoria*.

**antidune** (an'-ti-dune) 1 A transient form of ripple on a stream bed analogous to a sand dune. An antidune progressively moves upstream. 2 Any bed form, whether moving or not, that is produced by unidirectional flow and is in phase with surface water waves.

**antiform** (an'-ti-form) A fold, convex upward, in strata for which the stratigraphic sequence is not known. Cf. *anticline*.

**antigorite** (an-tig'-o-rite) A platy or lamellar mineral of the serpentine group,  $(\text{Mg,Fe})_3\text{Si}_2\text{O}_5(\text{OH})_4$ .

**antimony** (an'-ti-mo-ny) A hexagonal mineral, the native element Sb. It occurs in tin-white masses.

**antiperthite** (an-ti-perth'-ite) A variety of alkali feldspar consisting of parallel or subparallel intergrowths in which the sodium-rich phase (albite, oligoclase, or andesine) appears to be the host from which the potassium-rich phase (usually orthoclase) exsolved. Cf.

*perthite.*

**antipodes** (an-tip'-o-des [an-tip'-o-deez]) Two points on the earth's surface that are diametrically opposite each other. The term is often extended to include the whole region at the opposite end of a diameter of the earth, as Australia and New Zealand which lie roughly opposite the British Isles.

**antiroot** (an'-ti-root) According to the *Pratt hypothesis* of isostasy, crustal material of high density, into which the *roots* of mountain systems extend.

**antistress mineral** (an-ti-stress') A mineral such as feldspar, pyroxene, cordierite, or forsterite, whose formation in metamorphosed rocks is favored by conditions that are not controlled by shearing stress, but by thermal action and by hydrostatic pressure that is probably no more than moderate.

**antithetic fault** (an-ti-thet'-ic) A minor normal fault that is oriented opposite to the major fault with which it is associated Cf. *synthetic fault*.

**Antler orogeny** An orogeny which extensively deformed Paleozoic rocks of the Great Basin in Nevada during Late Devonian and Early Mississippian time. Its main expression is the emplacement of eugeosynclinal western rocks over miogeosynclinal eastern rocks along the Roberts Mountains thrust. Minor orogenic pulses followed the main event, extending into the Permian. It is broadly equivalent to the Acadi-

an orogeny of eastern North America.

**apatite** (ap'-a-tite) A group of hexagonal minerals consisting of calcium phosphate together with fluorine, chlorine, hydroxyl, or carbonate in varying amounts and having the general formula:  $\text{Ca}_5(\text{PO}_4, \text{CO}_3)_3(\text{F}, \text{OH}, \text{Cl})$ . Also, any mineral of this group, such as fluorapatite, chlorapatite, hydroxylapatite, carbonate-apatite, and francolite; when not specified, the term usually refers to *fluorapatite*. The apatite minerals occur as accessory minerals in igneous rocks, metamorphic rocks, and ore deposits; and most commonly as fine-grained and often impure masses as the chief constituent of *phosphate rock* and of bones and teeth Syn: *calcium phosphate*.

**apex** 1. In mining, the highest point of a vein relative to the surface, whether it crops out or not. The concept is used in mining law. 2. The summit or highest point of a mountain or other land form; esp. the highest point on an alluvial fan 3 The culmination or crest of an anticline. 4. The first-formed part of the shell of a gastropod, brachiopod, or straight cephalopod 5 The tip of the basal cavity or of a denticle of a conodont

**aphanite** (aph'-a-nite) Any fine-grained igneous rock whose constituents are too small to be distinguished by the unaided eye. Adj: *aphanitic*. Syn: *felsite*

**aphanitic** (aph-a-nit'-ic) Pertaining

to an aphanite.

**aphotic zone** (a-pho'-tic) That part of the ocean in which there isn't enough penetration of light for photosynthesis. Cf: *disphotic zone*; *euphotic zone*.

**API gravity** A standard adopted by the American Petroleum Institute for expressing the specific weight of oils. API gravity =  $(141.5/\text{specific gravity at } 60^\circ\text{F}) - 131.5$ . This arbitrary scale simplifies the construction of *hydrometers* because it enables the stems to be calibrated linearly. The lower the specific gravity, the higher the API gravity. Cf: *Baumé gravity*.

**aplite** (ap'-lite) A dike rock consisting essentially of quartz and alkali feldspar, with a fine-grained, sugary texture.

**Apollonian metamorphic rocks** (Ap-ol-lu'-ni-an) A small proportion of lunar rocks that possess polygonal granular texture and are composed of minerals with constant composition throughout a given rock. Etymol: in commemoration of the Apollo program.

**apophysis** (a-poph'-y-sis) A branch or offshoot of a larger intrusive body.

**Appalachia** (Ap-pa-la'-chi-a) One of the *borderlands* proposed by Schuchert in 1923, in this case along the southeast side of North America, seaward from the Appalachian orogenic belt. Most of the evidence for Appalachia, as originally conceived, is now otherwise interpreted. No former

large extensions of this borderland into the present Atlantic Ocean basin are possible, because of the oceanic crustal structure beyond the edge of the continental shelf.

**Appalachian orogeny** (Ap-pa-la'-chi-an) *Allegheny orogeny*.

**Appalachian Revolution** A concept, widely held in the first part of the 20th Century, that Paleozoic time was closed by a profound crustal disturbance, which especially deformed the rocks in the central and southern Appalachians. The term is misleading, and should be abandoned in favor of the term *Allegheny orogeny*.

**apparent dip** The *dip* of a bedding surface or fault plane as exposed in any section not at a right angle to the strike. It is always less than the *true dip*.

**apparent movement** The movement observed in any chance section across a fault. It is a function of several variables: the attitude of the fault, of the disrupted strata, and of the section on which the fault is observed, as well as the net or actual slip of the fault.

**apparent plunge** Inclination of a normal projection of lineation in the plane of a vertical cross section.

**apparent resistivity** The electrical resistivity of rocks as measured by an array of current and voltage electrodes in a borehole or on the surface of the earth. It is equivalent to the actual resistivity if the earth were truly homogeneous. In practice it is a weighted average of

resistivities. See: *resistivity*.

**apparent thickness** The thickness of a stratigraphic unit or other tabular body, measured at right angles to the surface of the land. Cf: *true thickness*.

**apparent velocity** The velocity with which the phase of a seismic wave train appears to travel along the surface of the earth. It exceeds the actual velocity if the wave train is not travelling parallel to the surface.

**applanation** (ap-pla-na'-tion) All processes that tend to reduce the relief of an area, causing it to become more and more planlike. These include lowering of the high parts by erosion and raising of the low parts by addition of material; the latter is usually more effective.

**apron** An extensive blanketlike deposit of unconsolidated material at the base of a mountain or in front of a glacier, e.g. a *bajada* or an *outwash plain*.

**aquamarine** (aq'-ua-ma-rine') A transparent, light bluish-green gem variety of beryl, and the birthstone for March.

**aqueous** (a'-que-ous) 1. Of or pertaining to water. 2. Made from or with water, as aqueous solutions. 3. Produced by the action of water, as aqueous sediments.

**aqueous ripple mark** A ripple mark made by waves or currents of water, as opposed to one made by wind.

**aquiclude** (aq'-ui-clude) A body of rock that will absorb water slowly but will not transmit it fast

enough to supply a well or spring. Cf: *aquifuge*; *aquitard*.

**aquifer** (aq'-ui-fer) A body of rock that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells and springs. Syn: *water horizon*; *ground-water reservoir*.

**aquifuge** (aq'-ui-fuge) A rock which contains no interconnected openings or interstices and therefore neither absorbs nor transmits water. Cf: *aquiclude*, *aquitard*.

**aquitard** (aq'-ui-tard) A *confining bed* that retards but does not prevent the flow of water to or from an adjacent aquifer, a leaky confining bed. It does not readily yield water to wells or springs, but may serve as a storage unit for ground water. Cf: *aquifuge*; *aquiclude*.

**aragonite** (a-rag'-o-nite) An orthorhombic mineral,  $\text{CaCO}_3$ , trimorphous with calcite and vaterite. It occurs in beds of gypsum and iron ore, in hot-spring deposits, in shallow marine banks and coral reefs, and in pearls and some shells.

**arborescent** (ar-bo-res'-cent) *dendritic*.

**Arbuckle orogeny** (Ar'-buck-le) The last major deformation in the Wichita orogenic belt of southern Oklahoma (Wichita and Arbuckle mountains, and subsurface). It is placed in the Late Pennsylvanian by its relations to limiting fossiliferous strata.

**archaeocyathid** (ar'-chae-o-cy-a'-thid [ar'-ke-o-cy-a'-thid]) Any

marine organism belonging to the phylum Archaeocyatha and characterized chiefly by a cone-, goblet-, or vase-shaped skeleton composed of calcium carbonate. The archaeocyathids have been variously classified as corals, sponges, protozoans, and calcareous algae. Range, Lower and Middle Cambrian, worldwide in distribution. Syn: *pleosponge*.

**Archean** (Ar-che'-an) Said of the rocks of the *Archeozoic*.

**Archeozoic** (Ar'-che-o-zo'-ic [Ar'-ke-o-zo'-ic]) The earlier part of Precambrian time, corresponding to Archean rocks. Cf. *Proterozoic*. Als. spelled *Archaeozoic*.

**archipelago** (ar'-hi-pe'l'-a-go) A sea, or an area in a sea, that contains numerous islands; also, the island group itself.

**arctic** (ar'-ctic) *n.* The area within the Arctic Circle, the region of the North Pole.—*adj.* Pertaining to cold, frigid temperatures, or to features, climate, vegetation, and animals characteristic of the arctic region.

**arcuate** (ar'-cu-ate) Curved or bowed.

**are** A metric unit of area equal to 100 square meters, 0.01 hectare, or 119.60 square yards. Abbrev. *a*.

**areal** (ar'-e-al) Pertaining to an area, as an *areal map*. Not to be confused with *aerial*.

**areal geology** The geology of an area, esp. the spatial distribution and position of stratigraphic units, structural features, and surface forms.

**areal map** A geologic map showing the horizontal extent and distribution of rock units exposed at the surface.

**arenaceous** (ar-e-na'-ceous) *1.* Said of a sediment or sedimentary rock consisting wholly or in part of sand-size fragments, or having a sandy texture or appearance; pertaining to sand or arenite. Also said of such a texture. The term implies no special composition, and should not be used as a syn. of "siliceous." Syn: *sandy*. *2.* Said of organisms growing in sandy places.

**arenite** (ar'-e-nite) *1.* A general name for consolidated sedimentary rocks composed of sand-sized fragments irrespective of composition, e.g. sandstone, graywacke, arkose, and calcarenite. Syn: *psammite*. See also: *lutite*, *rudite*. *2.* A "clean" sandstone that is well-sorted, contains little or no matrix material, and has a relatively simple mineralogic composition: specif. a pure or nearly pure, chemically cemented sandstone containing less than 10% argillaceous matrix. The term is used for a major category of sandstone, as distinguished from *wacke*.—*Etymol.* Latin *arena* "sand." *Adj.* *arenitic*.

**arête** (a-rê'te') A rocky sharp-edged ridge or spur, commonly present above the snowline in rugged mountains sculptured by glaciers, and resulting from the continued backward growth of the walls of adjoining cirques. *Etymol.* French, "fish bone".

**argentiferous** (ar-gen-tif'-er-ous) Containing silver.

**argentite** (ar'-gen-tite) A mineral  $\text{Ag}_2\text{S}$ . Isometric above  $179^\circ\text{C}$ ., it inverts to orthorhombic acanthite below this temperature. An important ore of silver.

**argillaceous** (ar-gil-la'-ceous) Applied to rocks or substances composed of clay minerals, or having a notable proportion of clay in their composition, esp. such sedimentary materials as marl and shale. Argillaceous rocks may be distinguished by a peculiar, "earthy" odor which they emit when breathed upon.

**argillic** (ar-gil'-lic) Pertaining to clay or clay minerals, e.g. "argillic alteration" in which certain minerals are converted to minerals of the clay group.

**argillite** (ar'-gil-lite) A compact rock, derived from mudstone or shale, more highly indurated than either of those rocks. It lacks the fissility of shale or the cleavage of slate. It is regarded as a product of weak metamorphism.

**arid** Said of a climate characterized by dryness, variously defined as rainfall insufficient for plant life or for crops without irrigation, less than 25 cm of annual rainfall; or a higher evaporation rate than precipitation rate. Syn: *dry*.

**arithmetic mean** (a-rith-met'-ic) The sum of the values of  $n$  numbers divided by  $n$ . It is usually referred to simply as the *mean*. Syn. *average*. Cf. *median*.

**Arkansas stone** (Ar'-kan-sas) A variety of *novaculite* found in the

Ouachita Mountains of western Arkansas. Also, a whetstone made of Arkansas stone.

**arkose** (ar'-kose) A feldspar-rich sandstone, typically coarse-grained and pink or red, derived from the rapid disintegration of granite or granitic rocks and often resembling them. Quartz is the chief mineral, feldspar makes up at least 25%, mineral cement is rare, and matrix material includes clay and iron oxide. Informal syn: *granite wash*. Adj: *arkosic*.

**arkosic sandstone** (ar-ko'-sic) 1. A sandstone with considerable feldspar, specif. one containing at least 25% feldspar and less than 20% matrix of clay, sericite, and chlorite. 2. A general term to include *feldspathic sandstone*, *subarkose*, and *arkose*.

**armored mud ball** A subspherical mass of silt or clay, which becomes coated or studded with coarse sand and fine gravel as it rolls along downstream. It is generally 5-10 cm in diameter.

**arrival** (ar-ri'-val) The initial appearance of seismic energy on a seismic record; the buildup of amplitude and the coherent lineup of energy signifying the passage of a wave front. See also: *first arrival*. Syn: *break*; *kick*.

**arroyo** (ar-roy'-o) 1. A term applied in the arid and semiarid southwestern U. S. to a small deep flat-floored channel or gully of an ephemeral or intermittent stream. It is usually dry and has steep or vertical banks of unconsolidated material. 2. The inter-



mittent stream that occupies such a channel.—Etymol: Spanish, "stream, gutter".

**arsenate** (ar'-se-nate) A mineral compound characterized by pentavalent arsenic and oxygen in the anion. An example is mimetite,  $Pb_3(AsO_4)_3Cl$ . Cf: *phosphate*; *wanadate*.

**arsenic** (ar'-se-nic) A hexagonal mineral, the native metallic element As. It is brittle and commonly occurs in steel-gray and granular or kidney-shaped masses.

**arsenopyrite** (ar'-se-no-py'-rite) A tin-white or steel-gray orthorhombic mineral,  $FeAsS$ . It occurs in crystalline rocks and esp. in lead and silver veins; it is the principal ore of arsenic. Syn: *mispickel*.

**arterite** (ar'-ter-ite) A *migmatite* of which the mobile portion was injected magma. Syn: *injection gneiss*.

**artesian** (ar-te'-sian) Pertaining to ground water under sufficient hydrostatic pressure to rise above the aquifer containing it.

**artesian aquifer** A water-bearing bed that contains water under hydrostatic pressure.

**artesian basin** A terrane, commonly basin-shaped, that includes an artesian aquifer whose potentiometric surface is above the land surface in the topographically lower parts of the area.

**artesian spring** A spring from which water issues under artesian pressure, generally through a fissure or other opening in the con-

fining bed that overlies the aquifer.

**artesian water confined ground water.**

**artesian well** A well in which the water rises above the top of the aquifer, whether or not it flows out at the land surface. Sometimes restricted to mean a *flowing artesian well*.

**arthrodire** (ar'-thro-dire) One of a group of extinct fishes that were abundant in the Devonian. They had heavily armored heads movably jointed to similar armor covering the anterior part of the body. Arthrodires grew to lengths of as much as 30 feet.

**arthrophycus** (ar'-thro-phy'-cus) A sand-filled rounded furrow, curving and branching, with faint but regularly spaced transverse ridges commonly bearing a median depression, probably representing a feeding burrow but also variously regarded as an inorganic structure or a trail produced by a worm, mollusk, or arthropod crawling over a soft-mud surface. The "branches" of the trace fossil may reach 60 cm in length. It was originally described as a plant fossil (seaweed) and assigned to the genus *Arthrophycus*.

**arthropod** (ar'-thro-pod) Any one of a group of invertebrates belonging to the phylum Arthropoda, characterized chiefly by jointed appendages and segmented bodies. Among the typical arthropods are trilobites, crustaceans, chelicerates, and myriapods. Range, Lower Cambrian to

present.

**articulate** (ar-tic'-u-late) adj. Jointed; provided with places where separation may naturally take place.—n. 1. of a class of brachiopods (the Articulata) in which the valves are held together along the hinge line by means of teeth and sockets 2. One of a subclass of the crinoids (the Articulata) in which the arms are highly jointed.

**articulation** (ar-tic'-u-la'-tion) 1. The action or manner of jointing, or the state of being jointed, as the interlocking of two brachiopod valves by teeth and sockets 2. Any movable joint between the rigid parts of an organism.

**artifact** (ar'-ti-fact) An object made or used by man.

**artificial brine** (ar-ti-fi'-cial) Brine produced from an underground deposit of salt or other soluble rock material in the process of *solution mining*.

**asbestos** (as-bes'-tos) 1. A commercial term for a group of silicate minerals that readily separate into thin, strong fibers that are flexible, heat resistant, and chemically inert, and are used in a wide variety of industrial products 2. A mineral of the asbestos group, esp. *chrysotile* (by far the most important), *amosite*, and *crocidolite*.

**aseismic ridge** (a-seis'-mic) A submarine ridge that is a fragment of continental crust; it is so named to distinguish it from the seismically active mid-oceanic ridge.

**ash** 1. In coal, the inorganic resi-

due left after burning. 2. *volcanic ash*.

**ash fall** 1. A rain of airborne volcanic ash falling from an eruption cloud. 2. A deposit of volcanic ash resulting from such a fall and lying on the ground surface.

**ash flow** A density current, generally a highly heated mixture of volcanic gases and ash, traveling down the flanks of a volcano or along the surface of the ground; it is produced by the explosive disintegration of viscous lava in a volcanic crater or by the explosive emission of gas-charged ash from a fissure or group of fissures. Ash flows of the type described at Mt. Pelée are considered to represent the feeblest type of the *nuée ardente*. The solid materials contained in a typical ash flow are unsorted and ordinarily include pumice, scoria, and blocks in addition to ash. Syn. *glowing avalanche*.

**asphalt** (as'-phal't) A dark brown to black viscous liquid or low-melting solid bitumen that consists almost entirely of carbon and hydrogen and is soluble in carbon disulfide. Natural asphalt is formed in oil-bearing rocks by the evaporation of the volatiles. Syn. *pitch*.

**asphalt-base crude** Crude oil containing a high percentage of naphthenic and asphaltic hydrocarbons Cf. *paraffin-base crude*.

**asphaltic sand** (as-phal'-tic) A natural mixture of asphalt and sand.

**asphaltite** (as'-phal-tite) Any one

of the naturally occurring black solid bitumens that are soluble in carbon disulfide and fuse above 230°F. Examples are uintahite, glance pitch, and grahamite.

**assay v.** In economic geology, to analyze the proportions of metals in an ore; to test an ore or mineral for composition, purity, weight, or other properties of commercial interest.—n. The test or analysis itself; its results.

**assay foot** In determining the *assay value* of an orebody, the multiplication of its *assay grade* by the number of feet along which the sample was taken. Cf: *assay inch*.

**assay grade** The percentage of valuable constituents in an ore, determined from assay. Cf: *assay value*.

**assay inch** In determining the *assay value* of an orebody, the multiplication of its *assay grade* by the number of inches along which the sample was taken. Cf: *assay foot*.

**assay limit** The limits of an ore body as determined by assay, rather than by structural, stratigraphic, or other geologic controls. Syn: *cut-off limit*.

**assay ton** A weight of 29.166+ grams, used in assaying to represent proportionately the *assay value* of an ore. Since it bears the same relation to the milligram that a ton of 2000 pounds does to the troy ounce, the weight in milligrams of precious metal obtained from an assay ton of an ore gives directly the number of ounces to the ton.

**assay value** The quantity of an ore's valuable constituents, determined by multiplying its *assay grade*, or percentage of valuable constituents, by its dimensions. Cf: *assay inch*; *assay foot*. The figure for precious metals is generally given in troy ounces per ton of ore.

**assemblage** (as-sem'-blage) 1. A group of relatively homogeneous organisms; specif. a group of fossils that occur at the same stratigraphic level, often with a connotation of localized geographic extent. Cf: *association*; *biocoenosis*; *community*. 2. The minerals that compose a rock, esp. an igneous or metamorphic rock.

**assemblage-zone** A biostratigraphic unit defined and identified by a group of associated fossils rather than by a single index fossil. Cf: *biozone*.

**assimilation** (as-sim'-i-la'-tion) The incorporation and digestion of solid or fluid foreign material, i.e. wall rock, in magma. The term implies no specific mechanisms or results. Such a magma, or the rock it produces, may be called *hybrid*. See also: *contamination*.

**association** (as-so'-ci-a'-tion) 1. A group of organisms, living or fossil, that occur together because of similar environmental requirements or tolerances. 2. *rock association*.

**asterism** (as'-ter-ism) The phenomenon of a rayed or star-shaped figure of light displayed by some crystals when viewed in reflected light, as in a star sap-

phire, or in transmitted light, as in some mica. It is caused by minute oriented acicular inclusions.

**asteroid** (as'-ter-oid) 1. One of the many small celestial bodies in orbit around the sun. Most asteroid orbits are between those of Mars and Jupiter. 2. A member of the subclass of echinoderms having broad arms not separable from the central disc, e.g. the starfish.

**aethenolith** (as-then'-o-lith) A body of magma that was formed by melting in response to heat generated by radioactive disintegration.

**aethenosphere** (as-then'-o-sphere) The layer or shell of the earth below the lithosphere, which is weak and in which isostatic adjustments take place, magmas may be generated, and seismic waves are strongly attenuated. The aethenosphere begins about 100 km below the surface and extends to a depth of about 350 km. Syn: *zone of mobility*.

**astroleme** (as'-tro-bleme) An ancient erosional scar on the earth's surface, produced by the impact of a cosmic body, and usually characterized by a circular outline and highly disturbed rocks showing evidence of intense shock; an eroded remnant of a meteoritic or cometary impact crater.

**astrogeology** (as'-tro-ge-ol'-o-gy) A science that applies the principles and techniques of geology, geochemistry, and geophysics to the study of the nature, origin, and history of the condensed matter and gases in the solar system

(usually excluding the earth). See also: *planetology*. Syn: *extraterrestrial geology*.

**asymmetrical** (a'-sym-met'-ri-cal) Without symmetry; having no center, plane, or axis of symmetry.

**asymmetrical ripple mark** The normal form of *current ripple mark*, with a short downstream slope and a comparatively long gentle upstream slope.

**Atlantic suite** (At-lan'-tic) One of two large groups of igneous rocks, characterized by alkalic and alkali-calcic rocks. Harker in 1909 divided all Tertiary and Holocene igneous rocks of the world into two main groups, the Atlantic suite and the *Pacific suite*, the former being so named because of the predominance of alkalic and alkali-calcic rocks in the nonorogenic areas of crustal instability around the Atlantic Ocean. Because there is such a wide variety of tectonic environments and associated rock types in the areas of these suites, the terms are now seldom used to indicate kindred rock types; e.g. Atlantic-type rocks are widespread in the mid-Pacific volcanic islands. Cf: *Mediterranean suite*. See also: *andesite line*.

**Atlantic-type coastline** A coastline that develops where the general structural trend of the land, such as mountain chains, is transverse to the margin of the ocean basin. The coast is generally irregular, with many inlets, as in areas around the Atlantic Ocean, e.g.

the southwest coastline of Ireland. See also: *Pacific-type coastline*.

**atmophile elements** (at'-mo-phil) 1.

The most typical elements of the atmosphere (H, C, N, O, I, He, and inert gases). 2. Elements that occur in the uncombined state or were concentrated in the gaseous primordial atmosphere.

**atmosphere** (at'-mos-phere) 1. The

gaseous envelope surrounding the earth. The atmosphere is very mobile, flowing readily under even a slight pressure gradient; elastic, compressible, capable of unlimited expansion, a poor conductor of heat, but able to transmit vibrations with considerable velocity. It consists by volume of 78% nitrogen, 21% oxygen, 0.9% argon, 0.03% carbon dioxide, and minute quantities of helium, krypton, neon, and xenon. The atmosphere is so compressed by its own weight that half is below 5.5 km from the earth's surface. Syn: *air*.

2. A unit of pressure. A normal atmosphere is equal to the pressure exerted by a vertical column of mercury 760 mm in height at 0°C with gravity taken at 980.665 cm/sec<sup>2</sup>; or about 14.7 pounds per square inch.

**atmospheric pressure** (at-mos-

pher'-ic) The force per unit area exerted by the atmosphere in any part of the atmospheric envelope. Some of the expressions for normal pressure at sea level are 76.0 cm, or 29.92 inches, of mercury; 1033.3 cm, or 33.9 feet, of water; 1033.3 grams per cm<sup>2</sup>; 1,013,250

dynes per cm<sup>2</sup>; 14.66 lb per in<sup>2</sup>; 1.01325 bars (1 bar=1,000,000 dynes/cm<sup>2</sup>); 1013.25 millibars.

**atmospheric radiation** The infrared radiation emitted by the atmosphere in two directions: upward into space and downward toward the earth. The latter is known as *counterradiation*.

**atmospheric water** Water in the atmosphere, in gaseous, liquid, or solid state.

**Atokan** (A-to'-kan) Lower Middle Pennsylvanian of North America.

**atoll** (at'-oll) A coral reef appearing in plan view as roughly circular, and surmounted by a ring of closely spaced coral islets that enclose a shallow lagoon. The reef is surrounded by deep water of the open sea, either oceanic or continental-shelf. Atolls range in diameter from 1 km to more than 130 km, and are esp. common today in the western and central Pacific Ocean. Several fossil atolls have also been described.

**atoll texture** In mineral deposits, the surrounding of one mineral by a ring of one or more other minerals. It commonly results from replacement of pyrite.

**atom percent** The percentage of an atomic species in a substance, calculated with reference to number of atoms rather than weight, number of molecules, or other criteria.

**attapulgitite** (at-ta-pul'-gite) *polygorzkitite*.

**attenuation** (at-ten-u-a'-tion) 1. A reduction in the amplitude or energy of a signal, such as might be

produced by passage through a filter 2 A reduction in the amplitude of seismic waves, as produced by *divergence*, reflection and scattering, and *absorption* 3 That portion of the decrease in seismic or sonar signal strength with distance that is not dependent on geometrical divergence, but on the physical characteristics of the transmitting medium

#### attenuation constant $Q$

**Atterberg grade scale** (At'-ter-berg) A geometric and decimal scale of grain size It is based on the unit value 2 mm and involves a fixed ratio of 10 for each successive grade yielding the diameter limits of 200, 20, 2.0, 0.2, 0.02, and 0.002 Subdivisions are the geometric means of the grade limits

**Atterberg limits** A collective term that includes the *liquid limit* and the *plastic limit*

**attitude** (at'-i-tude) A general term to describe the relation of a directional feature in a rock to a horizontal plane The attitude of planar features (bedding, foliation, joints, etc.) is described by giving the strike and dip The attitude of a linear feature (fold axis, lineation, etc.) is described by giving the strike of the horizontal projection of the linear feature and its plunge

**attrital coal** (at-tri'-tal) 1 A coal in which the ratio of anthraxylon to attritus ranges from 1:1 to 1:3 2 The groundmass or matrix of *banded coal*, in which vitrain and commonly fusain are embedded

**attrition** (at-tri'-tion) Wearing away by friction, specif the wear and tear that rock particles in transit undergo through mutual rubbing, grinding, knocking, scraping, and bumping, with resulting reduction in size and increase in roundness

**attritus** (at-tri'-tus) A composite term for dull grey to nearly black coal components of varying maceral content, unsorted and with fine granular texture, that form the bulk of some coals or are interlayered with bright bands of *anthraxylon* in others It is formed of a tightly compacted mixture of altered vegetal materials, especially those that were relatively resistant to complete degradation Cf *attrital coal* Syn *durain*

**augen** (au'-gen [ow'-gen]) In foliate metamorphic rocks large, lenticular mineral grains or aggregates which in cross section have the shape of an eye Feldspar, quartz, and garnet are common in augen Etymol German, "eyes"

**augen gneiss** A general term for a gneissic rock containing *augen*

**augen schist** A metamorphic rock characterized by the presence of recrystallized minerals as *augen* parallel to and alternating with schistose streaks

**augen structure** In some gneissic and schistose rocks, a structure consisting of minerals like feldspar, quartz, or garnet that have been squeezed into elliptical or lens-shaped forms resembling eyes (*augen*), which are common-

ly enveloped by essentially parallel layers of contrasting constituents such as mica or chlorite.

**augite** (au'-gite) A dark mineral of the pyroxene group,  $(\text{Ca}, \text{Na})(\text{Mg}, \text{Fe} + ^2\text{Al})(\text{Si}, \text{Al})_2\text{O}_6$ . It is an essential constituent of many basic igneous rocks.

**aulacogen** (au-lac'-o-gen) A tectonic trough on a craton, bounded by convergent normal faults. Aulacogens have a radial orientation relative to cratons and are open outward. Cf: *graben*; *rift*.

**aureole** (au'-re-ole) A zone surrounding an igneous intrusion in which contact metamorphism of the country rock has taken place. Syn: *contact zone*.

**auric** Pertaining to or containing gold, esp. in its trivalent state, as in auric chloride,  $\text{AuCl}_3$ .

**auriferous** (au-rif'-er-ous) Containing gold.

**austral** (aus'-trai) Southern.

**autecology** (aut-e-col'-o-gy) The study of the relationships between individual organisms or species and their environment. Cf: *synecology*.

**authigenic** (au-thi-gen'-ic) Formed or generated in place; specif. said of rock constituents that formed at the spot where they are now found; also, said of minerals that came into existence at the same time as, or later than, the rock of which they constitute a part. Ant: *allogenic*.

**autochthon** (au'-toch'-thon) A body of rocks that remains at its site of origin, where it is rooted to its basement. Rocks of an autoch-

thon may be mildly to considerably deformed. Cf: *allochthon*.

**autochthonous** (au-toch'-tho-nous) Formed or produced in the place where now found, e.g. coal that occurs where its original plants grew and decayed. The term is similar in meaning to *authigenic*, which refers to constituents rather than whole formations. Ant: *allochthonous*.

**autoclastic** (au-to-clas'-tic) A term applied to rocks that have been brecciated in place by mechanical processes, as by faulting or by shrinkage on desiccation. Cf: *crush breccia*.

**autogenetic** (au'-to-ge-net'-ic) 1. Said of landforms that have developed or evolved under local conditions, without interference by orogenic movements; esp. a topography resulting from the action of rain and streams upon land surfaces having free drainage to the sea. 2. Said of a type of drainage that is determined entirely by the conditions of the land surface over which the streams flow, as a drainage system developed solely by headwater erosion.—Syn: *autogenic*.

**autogenic** (au-to-gen'-ic) 1. Said of an ecologic succession that resulted from factors originating within the natural community and altering its habitat. Cf: *allogenic*. 2. *autogenetic*.

**autogeosyncline** (au'-to-ge'-o-syn'-cline) *intracratonic basin*.

**autointrusion** (au'-to-in-tru'-sion) A process wherein the residual liquid of a differentiating magma

is injected into rifts formed in the crystallized fraction at a late stage by deformation of unspecified origin.

**autolith** (au'-to-lith) 1. An inclusion in an igneous rock to which it is genetically related. Cf: *xenolith*. Syn: *cognate inclusion*. 2. In a granitoid rock, an accumulation of Fe-Mg minerals of uncertain origin, which may appear as a round, oval, or elongate segregation or clot.

**autometamorphism** (au'-to-met'-a-mor'-phism) 1. A process of recrystallization of an igneous mineral assemblage under conditions of falling temperature, attributed to the action of its own volatiles, e.g. serpentinization of peridotite or spilitization of basalt. 2. Alteration of an igneous rock by its own residual liquids. This process should rather be called *deuteric* alteration, as it is not considered to be metamorphic.

**autometasomatism** (au'-to-met'-a-so'-ma-tism) The process of alteration of newly crystallized igneous rock by its own last water-rich liquid fraction, which is trapped within the rock, generally by an impervious chilled border; a *deuteric* effect.

**automorphic** (au-to-mor'-phic) 1. Said of the holocrystalline texture of an igneous or metamorphic rock, characterized by crystals bounded by their own *rational faces*. Also said of a rock with such a texture. Syn: *idiomorphic*. Cf: *subautomorphic*. 2. A syn. of *euhedral*, obsolete in American

usage, but generally preferred in European usage.

**auxiliary fault** (aux-il'-ia-ry) A minor fault abutting against or branching from a major one. Syn: *branch fault*.

**auxiliary minerals** In the Johanssen classification of igneous rocks, those light-colored, relatively rare or unimportant minerals such as apatite, muscovite, corundum, fluorite, and topaz.

**available moisture** (a-vail'-a-ble) Moisture in soil that is available for use by plants.

**available relief** The total relief available for stream dissection in a given area, equal to the vertical distance between the height of the remnants of an original upland surface and the level at which grade is first attained by adjacent streams.

**avalanche** (av'-a-lanche) A large mass of snow, ice, soil, or rock, or mixtures of these materials, falling, sliding, or flowing very rapidly under the force of gravity. Velocities may sometimes exceed 500 km/hr.

**avalanche wind** A high wind or rush of air produced in front of a large landslide or of a fast-moving dry-snow avalanche, and sometimes causing destruction at a considerable distance from the avalanche itself.

**aven** A vertical shaft leading upward to the surface from a cave passage.

**aventurine** (a-ven'-tu-rine) n. A translucent variety of quartz or feldspar spangled throughout



with tiny inclusions (crystals, flakes, or scales) of such minerals as green mica, ilmenite, hematite, and limonite.—adj. Referring to the brilliant, spangled appearance of a mineral containing gold-colored or shiny inclusions. Cf: *gold-stone*.

**average arithmetic mean.**

**average igneous rock** A theoretical rock whose chemical composition is believed to be similar to the average composition of the outermost layer of the earth.

**average velocity** The ratio of the distance traversed along a ray path by a seismic pulse to the time required for that traverse.

**axial angle (ax'-i-al)** The acute angle between the two optic axes of a biaxial crystal (symbol  $2V$ ).

**axial compression** In experimental work with cylinders, a compression applied parallel with the cylinder axis.

**axial elements** In crystallography, the ratio of unit distances along crystallographic axes and the angles between these axes.

**axial plane** 1. The plane of the optic axes of an optically biaxial crystal. 2. A crystallographic plane that includes two of the crystallographic axes. 3. A planar surface that connects the *hinge lines* of the strata in a fold.

**axial-plane cleavage** Cleavage which is essentially parallel to the axial planes of folds in rock. Most axial-plane cleavage is closely related to the minor folds seen in individual outcrops, but some is parallel to the regional fold axes.

Most axial-plane cleavage is also *slaty cleavage*. Cf: *bedding-plane cleavage*.

**axial-plane folding** Large-scale secondary folding of pre-existing folds in response to movements that differed considerably from those which caused the original folding. Thus the axial planes have been folded.

**axial-plane separation** The distance between axial surfaces of adjacent anticlines and synclines where the folds occur in the same layer or surface.

**axial ratio** The ratio obtained by comparing the length of a crystallographic axis with one of the lateral axes taken as unity.

**axial surface** A surface that connects the *hinge lines* of the strata in a fold.

**axial symmetry** Symmetry of fabric, characterized by a unique axis of symmetry like that of an oblate or prolate spheroid. Such an axis has an infinite number of mirror planes passing through it and a single mirror plane normal to it. Syn: *spheroidal symmetry*.

**axial trace** The intersection of the axial plane of a fold with the surface of the earth or any other specified surface. Sometimes such a line is loosely and incorrectly called the axis.

**axis** 1. A straight line passing through a body, on which it revolves or may be supposed to revolve; a line passing through a body or system around which the parts are symmetrically arranged. 2. *crystal axis*. 3. *anticlinal axis*

or *synclinal axis*.

**axis of symmetry** An imaginary line in a crystal, about which it may be rotated so as to occupy the same position in space 2, 3, 4, or 6 times in a complete 360° revolution. Syn: *rotation axis; symmetry axis*.

**azimuth** (az'-i-muth) 1. The direction of a horizontal line as measured on an imaginary horizontal circle. It is the horizontal direction expressed as the angular distance between the vertical plane passing through the observer and the poles of the earth and the vertical plane passing through the observer and the object under observation. Azimuths are measured clockwise from north or clockwise from south. 2. A horizontal angle, measured clockwise, between the north meridian and the arc of the great circle connecting the epicenter of an earthquake and the receiver.

**azimuthal projection** (az-i-muth'-al) 1. A map projection in which a portion of the sphere is projected upon a plane tangent to it at the pole or any other point (which becomes the center of the map) and on which the azimuths (directions) of all lines radiating from the central point to all other points are the same as the azimuths of the corresponding lines on the sphere. Distortion at the central point is zero and scale distortions are generated radially from that point. All great circles

through the central point are straight lines intersecting at true angles. 2. A similar projection used in structural petrology.—Syn: *zenithal projection*.

**azimuth angle** 1. The horizontal angle, less than 180 degrees, between the plane of the celestial meridian and the vertical plane containing the observation point and the observed object (celestial body), reckoned from the direction of the elevated pole. In the astronomic triangle (composed of the pole, the zenith, and the star), it is the spherical angle at the zenith. 2. An angle in triangulation or in a traverse, through which the computation of azimuth is carried.

**azimuth compass** A magnetic compass, supplied with sights, for measuring the angle that a line on the earth's surface, or the vertical circle through a heavenly body, makes with the magnetic meridian.

**azonal soil** (a-zon'-al) A soil that lacks well-developed horizons and resembles the parent material. Syn: *immature soil*.

**azurite** (az'-ur-ite) 1. A deep-blue to violet-blue monoclinic mineral:  $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$ . It is an ore of copper and is a common secondary mineral associated with malachite in the upper (oxidized) zones of copper veins. 2. A semiprecious stone derived from compact azurite and used chiefly for ornamental objects.

## B

**back** The ceiling or roof of an underground mine

**backdeep** *epieugeosyncline*.

**backfill** Earth or other material used to refill a ditch, quarry, or other excavation, or waste rock used to support the roof after removal of ore from a stope

**background** 1 The normal slight radioactivity of the environment, due to cosmic rays and the earth's naturally radioactive substances.

2 In geochemical prospecting, the range in values representing the normal concentration of a given element in a material under investigation such as rock, soil, plants and water 3. The amount of pollutants present in the ambient air owing to natural sources

**backlimb** The more gently dipping side of an asymmetrical anticline

*Cf forelimb*

**back reef** 1 The landward side of a reef, including the area and its contained deposits between the reef and the mainland, the terrestrial deposits connecting the reef with the land, the reef flat The term is often used as an adjective, as in "back-reef facies" of lagoonal deposits 2 In some places, the side of the reef away from the open sea, even though no land may be nearby *Cf: fore reef*.

**backset bed** A cross-bed that dips against the direction of flow of a depositing current; e.g. an inclined layer of sand deposited on the gentle windward slope of a

transverse dune, often trapped by tufts of sparse vegetation.

**backset eddy** A small current revolving in the direction opposite to that of the great eddies that make up the ocean circulation. Backset eddies are common between the main current and the coastline

**backshore** 1. The upper zone of the shore or beach, lying between the high-water line of mean spring tides and the upper limit of shore-zone processes; it is acted upon by waves or covered by water only during exceptionally severe storms or unusually high tides. It is separated from the *foreshore* by the crest of the most seaward berm. 2 The area lying immediately at the base of a sea cliff. 3. *berm*.

**backsight** A sight or bearing on a previously established survey point, made to orient the plane table or to determine elevation of the instrument *Cf: foresight*

**back slope** 1 *dip slope*. 2 The gentler slope of a *mesa* or fault block It may be unrelated to the dip of the underlying rocks.

**back thrusting** Thrust faulting toward the interior of an orogenic belt, with the direction of displacement contrary to the general direction of tectonic transport, e.g., toward the southeast in the Appalachian folded belt.

**backwash** The seaward return of water running down the foreshore of a beach following an *uprush* of waves; also, the seaward-flowing mass of water so moved.

**bacteria** (bac-te'-ri-a) Single-celled microorganisms that lack chlorophyll and an evident nucleus. Most bacteria are capable of decomposing organic matter, and some cause disease. They have been in existence since the Precambrian.

**bacteriogenic** (bac-te'-ri-o-gen'-ic) Said of ore deposits formed by the action of anaerobic bacteria, by the reduction of sulfur or the oxidation of metals. See also: *iron bacteria*; *sulfur bacteria*.

**badlands** An intricately stream-dissected topography, developed on surfaces with little or no vegetative cover. Underlying material is generally unconsolidated or weakly cemented clay or silt, sometimes with gypsum or halite. Badlands may develop in humid areas if vegetation is removed through overgrazing or other causes.

**bahamite** (ba-ham'-ite) A limestone resembling the deposits now accumulating in the interior Bahama Banks. It is very pure, generally fine-grained, massively bedded, widely extensive, and without abundant fossils.

**bailer** A cylindrical steel container with a valve at the bottom for admission of fluid, attached to a wire line and used in *cable-tool drilling* for recovering and removing water, cuttings, and mud from the bottom of a well.

**bajada** (ba-ja'-da [ba-ha'-da]) A broad, gently inclined, detrital surface extending from the base of mountain ranges out into an in-

land basin, formed by the lateral coalescence of a series of *alluvial fans*, and having an undulating character due to the convexities of the component fans. It occurs most commonly in semiarid and desert regions, as in the SW U.S. A bajada is a surface of deposition, as contrasted with a *pediment*, and its top often merges with a pediment. Etymol: Spanish, "descent, slope". Syn: *apron*; *alluvial plain*; *compound alluvial plain*; *pedmont alluvial plain*.

**balance** (bal'-ance) The change in mass (the difference between accumulation and ablation) of a glacier over some defined interval of time, determined either as a value at a point, an average over an area, or the total mass change for the glacier. Syn: *regimen*. Cf: *net balance*.

**bald-headed anticline** An anticline whose crest has been eroded prior to deposition of an unconformably overlying sedimentary unit. Commonly used in petroleum geology.

**ballas** (bal'-las) A dense, globular aggregate of minute diamond crystals, having a confused radial or granular structure, whose lack of through-going cleavage planes imparts a toughness that makes it useful as an *industrial diamond*. Cf: *bort*; *carbonada*.

**ballast** (bal'-last) 1. Broken stone, gravel, slag, or similar material used in the roadbed of a railroad to provide a firm bed for the ties, distribute the load, hold the track in line, and facilitate drainage. 2.

Broken stone, gravel, or other heavy material used to provide weight in a ship and therefore improve its stability or control its draft.

**ball clay** A highly plastic, sometimes refractory clay, commonly characterized by the presence of organic matter, having unfired colors ranging from light buff to various shades of gray, and used as a bonding constituent of ceramic wares; *pipe clay*. It has high wet and dry strength, long vitrification range, and high firing shrinkage. Ball clay is so named because of the early English practice of rolling the clay into balls weighing 13-22 kg (30-50 lb) and having diameters of about 25 cm (10 in.).

**banco** An oxbow lake or meander cut off from a river by an alteration in its course. Local in Texas.

**band** 1. A stratum or lamina conspicuous because it differs in color or lithology from adjacent layers. 2. A range of frequencies between prescribed limits, e.g. the infrared band of electromagnetic radiation, ranging from 0.7  $\mu\text{m}$  to 1.0 mm. 3. A *glacier band*.

**banded** Said of a vein, sediment, or other deposit having alternating layers that differ in color or texture and that may or may not differ in mineral composition, e.g. *banded iron formation*.

**banded agate** An agate whose various colors are arranged in delicate parallel alternating bands or stripes of varying thickness. The bands are often wavy or zigzag

and occasionally concentric; they may be sharply demarcated or grade imperceptibly into one another. Cf: *onyx*.

**banded coal** Coal containing bands of varying luster. It is usually bituminous, although banding occurs in all ranks of coal. See also: *bright coal*.

**banded iron formation** A rock that consists of alternating bands of iron-rich minerals, generally hematite, and chert or fine-grained quartz. Abbrev: *bif*.

**banded ore** Ore that consists of layers of the same minerals differing in color, texture, or proportions, or of different minerals.

**banded structure** An outcrop feature developed in igneous and metamorphic rocks as a result of alternation of layers, stripes, flat lenses, or streaks differing conspicuously in mineral composition and/or texture.

**banding** 1. The appearance of *banded structure* in an outcrop of igneous or metamorphic rock as a result of *layering*. Cf: *flow layering*. 2. Thin bedding in sedimentary rocks, produced by deposition of different materials in alternating layers and conspicuous in cross-section. 3. Layered structure in glacier ice, due to alternating layers of coarse- and fine-grained ice or of bubbly and clear ice. Syn: *foliation*.

**bank** 1. A long narrow island along the Atlantic coast of the U.S., composed of sand, forming a barrier between a lagoon and the ocean. 2. A *shoal*, e.g.

Georges Bank. 3. The rising ground bordering a stream, designated right or left as to an observer facing downstream 4. A moundlike or ridgelike limestone deposit, consisting of shells formed in place by organisms such as crinoids and brachiopods; not rigid and wave-resistant like a reef 5. A coal deposit; the surface or face of a coal deposit that is being worked.

**bankfull stage** The elevation of the water surface of a stream flowing at *channel capacity*. Discharge at this stage is called bankfull discharge.

**bar** 1. An elongate offshore ridge, bank, or mound of sand or gravel, built by waves and currents, esp. at the mouth of a river or estuary or at a slight distance from the beach Submerged at least at high tide, a bar is commonly an obstruction to navigation. 2. A *river bar* or *channel-mouth bar*. 3. A unit of pressure equal to  $10^6$  dynes/cm<sup>2</sup>, equivalent to a mercurial barometer reading of 750.076 mm at 0°C. (or 29.5306 inches at 32°F), gravity being equal to 980.616 cm/sec<sup>2</sup>. It is equal to the mean *atmospheric pressure* at about 100 meters above mean sea level.

**barbed drainage pattern** A drainage pattern produced by tributaries that join the main stream in sharp bends that point upstream; it is usually the result of stream piracy that has reversed the direction of flow of the main stream.

**barbed tributary** A stream that

joins the main stream in an upstream direction, forming a sharp bend that points upstream and an acute angle that faces downstream at the point of junction.

**barchan** (bar'-chan) A dune having a crescentic ground plan, with the convex side facing the wind; the gentler slope is on the convex side, and the steeper slope on the concave side between the horns. The barchan is among the commonest of dune types, characteristic of very dry, inland desert regions the world over.

**bar finger** A long narrow sand body of lenticular cross section underlying a distributary channel in a bird-foot delta. The sand body, which is several times wider than the distributary channel, is produced by the seaward advance of the lunate bar at the distributary mouth.

**barite** (bar'-ite) An orthorhombic mineral, BaSO<sub>4</sub>, with a specific gravity of 4.5. It is used in paint and drilling mud, as a filler for paper and textiles, and is the principal ore of barium. Syn: *barytes*; *heavy spar*.

**barite dollar** A term used esp. in Texas and Oklahoma for a small disk-shaped mass of barite formed in a sandstone or sandy shale.

**barite rosette** A radially symmetrical cluster or aggregate of tabular sand-filled crystals of barite, usually forming in sandstone. Syn: *barite rose*; *petrified rose*.

**barograph** (bar'-o-graph) A *barometer* that makes a continuous

record of changes in atmospheric pressure. It is usually an aneroid type.

**barometer** (ba-rom'-e-ter) An instrument for measuring atmospheric pressure. It may be either a *mercury barometer* or an *aneroid barometer*. See also: *barograph*.

**barometric elevation** (bai-o-met'-ric) An elevation above mean sea level established by the use of a barometer

**barometric pressure** Atmospheric pressure as indicated or measured by a barometer

**barred basin** *silled basin*.

**barrel** As used in the petroleum industry, a volumetric unit of measurement equivalent to 42 U.S. gallons (158.76 liters).

**barrier** (bar'-ri-er) 1. *barrier beach* or *barrier island* 2. *ice shelf*. 3. *ground-water barrier*. 4. In an ecological sense, a condition, such as a topographic feature or a difference in water quality, that tends to prevent the free mixing of populations and individuals.

**barrier beach** A narrow elongate sand ridge rising slightly above high-tide level and extending generally parallel with the coast, but separated from it by a lagoon. Cf. *barrier island*.

**barrier flat** The relatively flat area, often occupied by pools of water, separating the exposed or seaward edge of a barrier beach or island and the lagoon behind it.

**barrier ice shelf** ice.

**barrier island** A long, narrow coastal island, representing a broadened *barrier beach*. It com-

monly has dunes, vegetated zones, and swampy terraces extending lagoonward from the beach. Also, a long series of barrier beaches. Examples. Long Beach, N.J., and the Lido in Venice.

**barrier reef** A long, narrow coral reef roughly parallel to the shore and separated from it by a lagoon of considerable depth and width. It may enclose a volcanic island (either wholly or in part), or it may lie a great distance from a continental coast (such as the Great Barrier Reef off the coast of Queensland, Australia). Generally, barrier reefs follow the coasts for long distances, often with short interruptions, termed *passes* or *channels*. Cf: *fringing reef*.

**Barrovian metamorphism** (Bar-ro'-vi-an) Regional metamorphism that can be zoned into metamorphic facies.

**bar theory** A theory advanced by Ochsenius in 1877 to account for thick deposits of salt, gypsum, and other evaporites. It assumes a lagoon separated from the ocean by a bar, in an arid climate. As water is lost by evaporation, additional water of normal salinity flows in from the ocean. Because some water in the lagoon is evaporating, the salinity there constantly increases, finally reaching a point where gypsum, salt, and other evaporites are deposited.

**barysphere** (bar'-y-sphere) *centrosphere*.

**basal cleavage** Mineral cleavage parallel to the basal pinacoid; e.g. in molybdenite.

**basal conglomerate** A well-sorted, lithologically homogeneous conglomerate that forms the bottom stratigraphic unit of a sedimentary series and that rests on a surface of erosion, thereby marking an unconformity; esp. a coarse-grained beach deposit of an encroaching or transgressive sea. It commonly occurs as a relatively thin widespread or patchy sheet, interbedded with quartz sandstone.

**basal pinacoid** A crystal form consisting of 2 parallel faces, so oriented as to cut the vertical axis *c* and to be parallel with planes of the lateral axes *a* and *b*. Syn: *basal plane*.

**basal plane** *basal pinacoid*

**basalt** (ba-salt') 1. A dark-colored igneous rock, commonly extrusive, composed primarily of calcic plagioclase and pyroxene; the fine-grained equivalent of *gabbro*. The plagioclase is normally zoned and usually ranges in composition from bytownite to labradorite; augite, pigeonite, and hypersthene are the common pyroxenes. Apatite and magnetite are almost always present, and olivine is common. 2. An igneous rock from the moon that consists of roughly equal amounts of augite, plagioclase, and ilmenite.

**basaltic layer** (ba-sal'-tic) A syn. of *sima*, so named for its supposed petrologic composition. It is also called the *gabbroic layer*.

Cf: *granitic layer*. A layer is sometimes termed "basaltic layer" if it possesses the appropriate seismic velocity ( $\approx 6.5$ - $7.0$  km/s), although nothing may be known about its composition.

**basal till** Till carried at or deposited from the under surface of a glacier.

**basanite** (bas'-a-nite) A basaltic rock composed of calcic plagioclase, augite, olivine, and a feldspathoid (nepheline, leucite, or analcime). Essentially a feldspathoid olivine basalt.

**base** 1. A substance which, when added to water, increases the hydroxide-ion concentration. 2. An informal term for the hydrocarbon series that is dominant in a given crude oil, e.g. asphalt-base crude. 3. The aboral end of an echinoderm theca or a crinoid calyx; also, the area adjacent to the aboral side of a conodont element. 4. In surveying, a base line.

**base correction** A correction or adjustment of geophysical measurements to express them relative to the values of a *base station*.

**base course** A bottom layer of coarse gravel or crushed stone, generally of specified character and thickness, constructed on the subgrade or subbase of a highway or structure for the purpose of distributing load, providing drainage, and minimizing frost action.

**base exchange** A reaction in which cations adsorbed on the surface of a solid, such as a clay mineral or a zeolite crystal, are replaced by



cations in the surrounding solution. Syn: *cation exchange*.

**base level** *n.* The theoretical limit or lowest level toward which erosion of the earth's surface constantly progresses but seldom, if ever, reaches; esp. the level below which a stream cannot erode its bed. The general or *ultimate base level* for the land surface is sea level, but *temporary base levels* may exist locally. The base level of erosion by wind may be above or below sea level; that of marine erosion is the lowest level to which marine agents can cut a bottom.—*v.* To reduce by erosion to, or toward the condition of a plain at, base level.

**base line** *1.* A surveyed line established with more than usual care, which serves as a reference to which surveys are coordinated and correlated. Syn: *base*. *2.* One of a pair of coordinate axes (the other being the *principal meridian*) used in the U.S. Public Land Survey system. It consists of a line extending east and west on a parallel of latitude, along which standard township, section, and quarter-section corners are established. *3.* The center line of location of a railway or highway; the reference line for the construction of a bridge or other engineering structure.

**base map** A map of any kind showing essential outlines necessary for adequate geographic reference, on which additional or specialized information is plotted for a particular purpose; esp. a topo-

graphic map on which geologic information is recorded.

**basement** *1.* The undifferentiated rocks, commonly igneous and metamorphic, that underlie the rocks of interest, commonly sedimentary, in a given area. In many regions the basement is of Precambrian age, but it may be much younger. Syn: *basement complex*.

*2.* The crust of the earth below sedimentary deposits, extending downward to the Mohorovičić discontinuity.—*adj.* Said of materials, processes, or structures originating or occurring in the basement.

**basement complex** *basement*.

**base metal** *1.* Any of the more common and more chemically active metals, e.g. lead, copper. *2.* The principal metal of an alloy, e.g. the copper in brass.—*Cf:* *noble metal*.

**base net** A small *net* of triangles and quadrilaterals, starting from a measured *base line* and connecting with a line of the main scheme of a *triangulation net*; e.g. a triangle formed by sighting a point from both ends of a base line, or two adjacent triangles with the base line common to both. It is the initial figure in a triangulation system.

**base of weathering** In seismic work, the boundary between the low-velocity surface layer and an underlying comparatively high-velocity layer. It may correspond to the water table. The boundary is important in deriving time corrections for seismic records.

**base station** An observation point used in geophysical surveys as a reference, to which measurements at additional points can be compared. See also: *base correction*.

**basic** 1. Said of an igneous rock having a relatively low silica content, roughly 45 to 50%; e.g. gabbro, basalt. Basic rocks are relatively rich in iron, magnesium, and/or calcium, and thus include most mafic rocks as well as other rocks. "Basic" is one of four subdivisions of a widely used system for classifying igneous rocks based on their silica content: *acidic*, *intermediate*, *basic*, and *ultrabasic*. Cf. *femic*. 2. Said loosely of any igneous rock composed chiefly of dark-colored minerals. Cf. *silicic*, *mafic*. 3. Said of a plagioclase that is calcic.

**basic front** In granitization, an advancing zone enriched in calcium, magnesium and iron, which is said to represent those elements in the rock being granitized that are in excess of those necessary to form granite.

**basification** (ba'-si-fi-ca'-tion) Enrichment of a rock in elements such as calcium, magnesium, iron, and manganese.

**basin** 1. A depressed area with no surface outlet. The term is widely applied, e.g. to a lake basin, to a ground-water basin, to a shallow depression on the sea floor, or to a circular depression on the moon's surface. 2. The drainage area of a stream. 3. A low area in the crust, of tectonic origin, in which sediments have ac-

cumulated, e.g. the Michigan Basin, the Bighorn Basin of Wyoming, or the Appalachian Basin. Such features were drainage basins at the time of sedimentation but are not necessarily so today. Syn: *structural basin*.

**basin-and-range** Said of a topography, landscape, or physiographic province characterized by a series of tilted fault blocks forming longitudinal, asymmetric ridges or mountains and broad, intervening basins, specif. the Basin and Range physiographic province in SW U.S.

**basin-and-range structure** Regional structure dominated by fault-block mountains separated by sediment-filled basins.

**basin order** The number assigned to an entire drainage basin contributing to the stream segment of a given order and bearing an identical integer designation; e.g. a first-order basin contains all of the drainage area of a first-order stream. See also: *stream order*.

**basin range** A mountain range that owes its elevation and structural form mainly to faulting and tilting of strata and that is surrounded by alluvium-filled basins or valleys. Etymol. from the Great Basin, a region in SW U.S. characterized by fault block mountains. See also: *basin-and-range structure*.

**bastnaesite** (bast'-nae-site) A wax-yellow to reddish-brown mineral:  $(\text{Ce}, \text{La})\text{CO}_3(\text{F}, \text{OH})$ . It occurs in alkaline igneous rocks, esp. carbonatite, as at Mountain Pass.

**Calif Bastnaesite** is the chief U.S. source of rare-earth elements.

**batholith** (bath'-o-lith) A large, generally discordant plutonic mass that has more than 40 sq mi (100 km<sup>2</sup>) of surface exposure and no known floor. Its formation is believed by most investigators to involve magmatic processes. Also spelled: *bathylith*.

**bathyal** (bath'-y-al) Pertaining to the ocean environment between 200 and 4000 meters; also, pertaining to the organisms of that environment.

**bathymetric chart** (bath'-y-met'-ric) A topographic map of the bed of the ocean or other body of water, with depths indicated by contours (isobaths) drawn at regular intervals.

**bathypelagic** (bath'-y-pe-lag'-ic) Pertaining to the open water of bathyal depth

**bathyscaph** (bath'-y-scaph) A manned, submersible vehicle for deep-sea exploration; it is somewhat navigable, in contrast to a *bathysphere*

**bathysphere** (bath'-y-sphere) A manned submersible sphere that is lowered into the deep ocean by cable for observations unlike the *bathyscaph*, it is not navigable.

**battery ore** (bat'-ter-y) Manganese oxide ore suitable for use in dry cells.

**Baumé gravity** The specific weight of a liquid, measured on a scale based on the weight of water; it is used in the petroleum industry for denoting the specific weight of oils. For liquids lighter than wa-

ter, degrees Baumé = 140/(specific gravity of the liquid at 60°F) - 130. Cf: *API gravity*.

**bauxite** (baux'-ite) A gray, yellow, or reddish-brown rock composed of a mixture of various aluminum oxides and hydroxides (principally gibbsite, boehmite, and diaspor), along with free silica, silt, iron hydroxides, and esp. clay minerals; a highly aluminous *laterite*. It is a common residual or transported constituent of clay deposits in tropical and subtropical regions, and occurs in concretionary, compact, earthy, pisolitic, or oolitic forms. Bauxite is the principal commercial source of aluminum.

**bauxitization** (baux'-it-i-za'-tion) Development of bauxite from either primary aluminum silicates or secondary clay minerals, under aggressive tropical or subtropical weathering conditions.

**b axis** 1. One of the crystallographic axes used as reference in crystal description. It is the axis that is oriented horizontally, right to left. 2. In deformed rocks, the direction in the plane of movement at right angles to the direction of tectonic transport. *b* lies on a slickenside surface at right angles to the striae.

**bay** 1. A recess in the shore or an inlet of a sea or lake between two capes or headlands, not as large as a gulf but larger than a cove. Cf: *bight*; *embayment*. 2. Any landform resembling a bay of the sea, as a lowland recess in a range of hills; also a piece of low marshy

ground producing many bay trees 3 *Carolina bay*.

**bay bar** *baymouth bar*

**bayhead bar** A bar built a short distance out from the shore at the head of a bay

**baymouth bar** A bar of sand or gravel extending partially or entirely across the mouth of a bay. It usually connects two headlands, thus straightening the coast. Syn *hay bar*

**bayou** (bay'-ou) 1 A term applied to many local water features in the lower Mississippi River basin and in the Gulf Coast region of the U.S., esp. Louisiana. Its general meaning is a creek or secondary watercourse that is tributary to another body of water, esp. a sluggish and stagnant stream that follows a winding course through alluvial lowlands, coastal swamps, or river deltas. 2 A distributary flowing through a delta or through swamps or marshlands. 3 An *oxbow lake*. 4 An estuarine creek (generally tidal), or an inlet, bay, or open cove on the Gulf Coast

**bc fracture** A tension fracture parallel with the *bc plane* and normal to *a*. The orientation of these fractures affords a criterion for direction sense of shear

**bc plane** A plane that is perpendicular to the plane of movement and parallel to the *b* direction in that plane, i.e., perpendicular to *a*, the direction of tectonic transport

**beach** The gently sloping shore of a body of water which is washed

by waves or tides, especially the parts covered by sand or pebbles  
**beach berm** *berm*.

**beach cusp** A low seaward projection of sand or pebbles, formed on the foreshore of a beach by wave action, specif. a relatively small *cusp* along a straight beach. Distance between beach cusps is 10-60 m, it generally increases with increase in wave height

**beach face** The section of the beach normally exposed to the action of the wave uprush, the foreshore of a beach

**beach placer** A *placer* deposit of valuable heavy minerals, e.g. zircon, ilmenite, or rutile, on a contemporary or ancient beach or along a coastline

**beach plain** *wave-built terrace*

**beach profile of equilibrium** The trace of a beach surface on a vertical plane normal to the shoreline. It is commonly concave upward, as the slope is steeper above high water and more gentle seaward

**beach ridge** A low, essentially continuous mound of beach and dune material heaped up by the action of waves and currents on the backshore of a beach beyond the present limit of storm waves or of ordinary tides, and occurring singly or as one of a series of approximately parallel deposits. The ridges represent successive positions of an advancing shoreline.

**beach scarp** An almost vertical slope fronting a berm on a beach, caused by wave erosion. It may range in height from several centi-

meters to a few meters, depending on the character of the wave action and the nature and composition of the beach.

**beaded drainage** A pattern of short minor streams connecting small pools, characteristic of an area underlain by permafrost.

**Beaman stadia arc** (Bea'-man) A graduated arc attached to the vertical arc of an alidade, which enables the observer to determine differences in elevation of the instrument and the stadia rod without the use of vertical angles

**bearing** The direction of a line with reference to the cardinal points of the compass, commonly expressed as an angle of less than 90° measured east or west from the meridian and referred to either the north or the south point, e.g. N. 30° E. or S. 30° W. Cf: *azimuth, magnetic bearing.*

**Beaufort wind scale** (Beau'-fort) A system of estimating wind velocity commonly used at sea. It is based on the visible effects of wind on the sea surface or on fixed objects. Code numbers and descriptive terms are assigned to various ranges, e.g. a wind velocity of 8-10 mph (or 7-10 knots) is Beaufort Code Number 3, and is called a "gentle breeze". The scale is a modernized version of that devised by Admiral Beaufort of the British Navy early in the nineteenth century.

**Becke line** In the *Becke test*, a bright line, visible under the microscope, that separates substances of different refractive in-

dice.

**Becke test** In optical mineralogy, a test under the microscope for comparing indices of refraction. The bright *Becke line* appears to move toward the mineral grain or immersion liquid of higher refractivity as the tube of the microscope is raised, and toward the less refractive material when the tube is lowered.

**bed** 1. The smallest *lithostratigraphic unit*, commonly ranging in thickness from a centimeter to a meter or two and distinguishable from beds above and below. The term is generally applied to sedimentary strata, but it may be used for other types, as an ash bed. Syn. *layer, stratum*. 2. The floor of a body of water.

**bedded** 1. Arranged or deposited in layers or beds, esp. said of sedimentary rocks. The term may also be applied to stratified material of other origin, e.g. volcanic ash. 2. Said of a vein or other mineral deposit that follows the bedding in a sedimentary rock; also, said of a layered replacement deposit. Cf: *stratabound; stratiform.*

**bedding** 1. The arrangement of a sedimentary rock in layers; stratification. Also, the general character or pattern of the beds and their contacts within a rock mass, as *cross-bedding* and *graded bedding*. The term may be applied to a layered arrangement in igneous or metamorphic rock. 2. A quarrymen's term for a structure occurring in granite and similar massive rocks that allows

them to split in well-defined planes horizontally or parallel to the land surface. Cf: *sheeting*.

**bedding cleavage** *bedding-plane cleavage*.

**bedding fault** A fault that is parallel to the bedding of the rock in which it occurs.

**bedding fissility** The property possessed by a sedimentary rock (esp. shale) of tending to split more or less parallel to the bedding; *fissility* along bedding planes. It is a primary foliation that forms in a sedimentary rock while the sediment is being deposited and compacted, and is a result of the parallelism of the platy minerals to the bedding plane.

**bedding joint** A joint parallel to the bedding.

**bedding plane** In sedimentary or stratified rocks, the division plane that separates each successive layer or bed from the one above or below. It commonly marks a visible change in lithology or color.

**bedding-plane cleavage** Cleavage that is parallel to the bedding plane. Cf: *axial-plane cleavage*. Syn: *bedding cleavage*; *parallel cleavage*.

**bedding-plane slip** The slipping of sedimentary strata along bedding planes during folding. Syn: *flexural slip*.

**Bedford limestone** A commercial name for *spergenite*, a uniform gray or buff Mississippian limestone extensively quarried in the vicinity of Bedford, Ind., for building stone. Syn: *Indiana limestone*.

**bed form** Any deviation from a flat bed, generated by stream flow on the bed of an alluvial channel.

**bed load** The part of a stream's load that is moved on or immediately above the stream bed, such as the larger or heavier particles (boulders, pebbles, gravel) rolled along the bottom; the part of the load that is not continuously in suspension or solution. Syn: *bottom load*; *traction load*.

**bed material** The material of which a stream bed is composed.

**bedrock** The solid rock that underlies gravel, soil, or other superficial material. Also spelled: *bed rock*.

**beds** An informal term for strata that are incompletely known, constitute a lithologically similar succession, or are of local economic significance, e.g. "beds of Permian age", "key beds", "coal beds".

**beheaded stream** (be-head'-ed) The diminished lower part of a stream whose headwaters have been captured by another stream.

**beheading** 1. The cutting-off of the upper part of a stream and the diversion of its headwaters into another drainage system by piracy. 2. The removal of the upper part of a stream's drainage area by wave erosion.

**beidellite** (bei'-del-lite [by'-del-lite]) An aluminum-rich member of the smectite group of clay minerals. It is a common constituent of soils, and of certain clay deposits such as *metabenionite*.

**belemnite** (bel'-em-nite) An extinct

type of cephalopod, known from cigar-shaped fossils of a part of the internal skeleton.

**belled coastal plain** A broad, maturely dissected coastal plain on which a series of roughly parallel *cuestas* alternates with subsequent lowlands or *vales*; e.g. the Gulf Coastal Plain through Alabama and Mississippi.

**bench** 1. A long, narrow, relatively level terrace or platform breaking the continuity of a slope. The term sometimes denotes a form cut in solid rock, as distinguished from one (such as a *terrace*) in unconsolidated material. 2. A *wave-cut bench*. 3. A bed of coal; either a coal seam separated from adjacent seams by a parting of "slate" (shale), or one of several layers within a coal seam that may be mined separately from the others. 4. A thickness of rock in a quarry or open-cut mine that is worked at one time or in one series of operations.

**bench mark** A relatively permanent metal tablet or other mark firmly embedded in a fixed and enduring natural or artificial object, indicating a precisely determined elevation above or below a standard datum (usually sea level), bearing identifying information, and used as a reference in topographic surveys and tidal observations. Abbrev: BM.

**bench placer** Gravel beds on the side of a valley, above the present stream bottom, which are mined as a placer.

**bed** A curve in a river channel

whose lateral changes involve a decrease in radius. Bends generally grow into meanders.

**beneficiation** (ben'-e-fi'-ci-a'-tion) Improvement of the grade of ore by milling, flotation, sintering, gravity concentration, or other processes.

**Benioff zone** (Ben'-i-off) A plane beneath the trenches of the Circum-Pacific seismic belt, dipping toward the continents at an angle of about 45°, along which earthquake foci cluster. The earthquakes are believed to be generated along the upper boundary of plates of the lithosphere as they sink into the upper mantle. See also: *plate tectonics*. Syn: *Benioff seismic zone*.

**benthic** (ben'-thic) Pertaining to the *benthos*; also, said of that environment. Syn: *demersal*; *benthonic*.

**benthonic** (ben'-thon'-ic) *benthic*.

**benthos** (ben'-thos) Those forms of marine life that are bottom-dwelling; also, the ocean bottom itself. Certain fish that are closely associated with the benthos may be included. Adj: *benthic*.

**bentonite** (ben'-ton-ite) A soft plastic light-colored clay formed by chemical alteration of volcanic ash. It is composed essentially of montmorillonite and related minerals of the smectite group. The properties of bentonite depend largely on its ion-exchange characteristics. See also: *sodium bentonite*; *calcium bentonite*; *potassium bentonite*.

**bergschrand** (berg'-schrand) The

crevasse occurring at the head of an *alpine glacier*, which separates the moving snow and ice of the glacier from the relatively immobile snow and ice adhering to the headwall of a *cirque*

**berg till** 1 A glacial till deposited intact by grounded icebergs in fresh or saline water bordering an ice sheet 2 A lacustrine or marine clay containing boulders and stones dropped into it by melting icebergs —Syn *floe till*

**berm** 1 A low shelf or narrow terrace on the backshore of a beach formed of material thrown up and deposited by storm waves It is generally bounded on one side by a beach ridge or beach scarp Some beaches have no berms, others have several Syn *beach berm* 2 A remnant of a late-mature erosion surface that has been uplifted and partially dissected by erosion 3 The margin or shoulder of a road, adjacent to the paved portion

**berm crest** The seaward limit and generally the highest point of a berm on a beach The crest of the most seaward berm separates the foreshore from the backshore

**Bertrand lens** (Ber'-trand) A removable lens in the tube of a petrographic microscope that is used in conjunction with convergent light to form interference figures

**beryl** A hexagonal mineral,  $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$  It is an ore of beryllium, occurring in granitic pegmatites Emerald and aquamarine are gem varieties

**beta particle** A particle, emitted from an atomic nucleus during a type of radioactive decay, which is physically identical with either the electron or the positron Cf *alpha particle*; *gamma radiation* Less-preferred syn. *beta ray*

**beta quartz** The polymorph of quartz that is stable from 573°C to 870°C, and that has a lower refractive index and birefringence than those of *alpha quartz* It occurs as phenocrysts in quartz porphyries, graphic granite and granite pegmatites Also spelled  $\beta$  quartz Syn *high quartz*

**beveling** (bev'-el-ing) The planing-off by erosion of the outcropping edges of strata Cf *truncation*

**B horizon** The zone in the soil profile that is enriched in clay minerals and in sesquioxides leached from the overlying *A horizon* It is a "zone of accumulation" Approx syn *subsoil*

**BHP bottom-hole pressure**

**biaxial** (bi-ax'-i-al) Said of a crystal having two optic axes and three indices of refraction, e.g. of an orthorhombic, monoclinic, or triclinic crystal Cf *uniaxial*

**bicarbonate** (bi-car'-bon-ate) A salt containing a cation and the radical  $\text{HCO}_3$ , e.g.,  $\text{NaHCO}_3$

**bif banded iron formation**

**"big bang" hypothesis** The hypothesis that the currently observed expansion of the universe may be extrapolated back to a primeval cosmic fireball Depending on the ratio of the initial expansion velocity to the mass of the universe, which is relatable to



currently observable parameters, the universe may reach a maximum distension and collapse in on itself.

**bight** 1. A bend or curve in the shoreline of an open coast. 2. A tract of water or a large bay formed by a bight: an open bay. Example: the Great Australian Bight.

**bilateral symmetry** (bi-lat'-er-al) With the individual parts of an organism arranged symmetrically along the two sides of an elongate axis, or in equivalent right and left halves. Cf: *radial symmetry*

**binary system** (bi'-na-ry) A system consisting of two components, e.g., the system  $MgO-SiO_2$ .

**binomen** (bi-no'-men) Two Latin or Latinized words which, taken together, are the name of a *species*. The first word is its *generic* name and the second its *specific* name. Syn: *binomial*.

**binomial** (bi-no'-mi-al) n. A syn of *binomen*.

**binomial system** A system of nomenclature for plants and animals in which the name of each species consists of a *binomen*, e.g. *Phacops rana*.

**biochemical oxygen demand** (bi-o-chem'-i-cal) The amount of oxygen, measured in parts per million, that is removed from aquatic environments rich in organic material by the metabolic requirements of aerobic micro-organisms. Abbrev: BOD. Cf: *chemical oxygen demand*. Syn: *biological oxygen demand*.

**biochemical rock** A sedimentary

rock characterized by, or resulting directly or indirectly from, the chemical processes and activities of living organisms; e.g. bacterial iron ores and certain limestones.

**biochron** (bi'-o-chron) The time represented by a *biozone*.

**biochronology** (bi'-o-chron-ol'-o-gy) *Geochronology* based on the relative dating of geologic events by biostratigraphic or paleontologic methods or evidence; i.e. the study of the relationship between geologic time and organic evolution.

**bioclastic rock** (bi-o-clas'-tic) 1. A sedimentary rock consisting of fragmental or broken remains of organisms, such as a limestone composed of shell fragments Cf. *biogenic rock*. 2. A rock consisting primarily of fragments that are broken from pre-existing rocks, or are pulverized or arranged, by the action of living organisms, such as plant roots or earthworms. The rock need not consist of organic material. The term includes "rocks" (such as concrete) that owe their existence to man's activities.

**biocoenosis** (bi'-o-coe-no'-sis [bi'-o-si-no'-sis]) 1. A set of fossil remains found in the same place where the organisms lived. Cf: *thanatocoenosis*. Syn: *life assemblage*. 2. A group of organisms that live closely together and form a natural ecologic unit. Cf: *community*. —Var: *biocenosis*; *biocoenose*; *biocenose*. Plural: *biocoenoses*. Etymol: Greek *bios*, "mode of life" + *koinos*, "gener-

al, common".

**biodegradable** (bi'-o-de-grad'-a-ble) Subject to decomposition by micro-organisms.

**biocoology** (bi'-o-e-col'-o-gy) The branch of ecology concerned with the relationships between plants and animals in their common environment.

**biofacies** (bi-o-fa'-cies) 1. A body of sediment or rock distinguished from adjacent bodies solely on the basis of its fossils or their environmental implications. 2. The biological aspect or fossil character of a stratigraphic facies; the biological characteristics of a sedimentary deposit. 3. An ecological association of fossils, the fossil record of a *biocoenosis*. —Syn: *biologic facies*.

**biogenesis** (bi-o-gen'-e-sis) 1. Formation by the action of organisms. 2. The doctrine that all life has been derived from previously living organisms.

**biogenetic law** (bi'-o-ge-net'-ic) The so-called "law" of recapitulation: ontogeny recapitulates phylogeny.

**biogenic rock** (bi-o-gen'-ic) An *organic rock* produced directly by the physiological activities of organisms, e.g. coral reefs, shelly limestone, pelagic ooze, or coal. Cf: *bioclastic rock*.

**biogeochemical cycling** (bi'-o-ge'-o-chem'-i-cal) The cycling of chemical constituents through a biological system.

**biogeochemical prospecting** Exploration for mineral deposits, based on the chemical analysis of

systematically sampled plants in a region, in order to detect biological concentrations of elements that might reflect hidden ore bodies. The trace-element content of one or more plant organs is most often measured. Cf: *geobotanical prospecting*.

**biogeochemistry** (bi'-o-ge'-o-chem'-is-try) A branch of geochemistry that deals with the effects of life processes on the distribution and fixation of chemical elements in the biosphere. Cf: *hydrogeochemistry*; *lithogeochemistry*.

**bioherm** (bi'-o-herm) A moundlike or circumscribed mass of rock built by sedentary organisms such as corals, stromatoporoids, or algae, and enclosed in rock of different lithological character; an *organic reef*. Cf: *biostrome*.

**biohorizon** (bi'-o-ho-ri'-zon) A surface of biostratigraphic change or of distinctive biostratigraphic character, esp. valuable for correlation; it is commonly a *biozone* boundary. In theory, a biohorizon is strictly a surface or interface; in practice, it may be a thin biostratigraphically distinctive bed. Cf: *chronohorizon*; *lithohorizon*.

**biolithite** (bi-o-lith'-ite) A limestone constructed by organisms that grew and remained in place, characterized by a rigid framework of carbonate material that binds allochem grains and skeletal elements. It is typical of reef cores. The major organism should be specified when using the term; e.g. "algal-mat biolithite".

**biologic facies** (bi-o-log'-ic) *biofacies*.

**biology** (bi-ol'-o-gy) The study of all organisms, esp. living ones; includes *neontology* and *paleontology*, but most often is used to imply neontology alone.

**biomass** (bi'-o-mass) The total mass of living organisms in a given area, in terms of weight or volume per unit area.

**biome** (bi'-ome) A climax community that characterizes a particular natural region; esp. a particular type of vegetation, climatically bounded, which dominates a large geographic area.

**biomechanical rock** (bi'-o-mechan'-i-cal) *bioclastic rock*.

**biometrics** (bi-o-met'-rics) Statistics as applied to biologic observations and phenomena.

**biomicrite** (bi-o-mic'-rite) A limestone consisting of a variable proportion of fossil skeletal debris and carbonate mud. When using the term, the major organism should be specified; e.g., "crinoid biomicrite." Cf: *micrite*.

**biophile** (bi'-o-phil) Said of those elements that are the most typical in organisms and organic material, or are concentrated in and by living plants and animals.

**biosome** (bi'-o-some) A body of sediment deposited under uniform biological conditions; the biostratigraphic equivalent of *lithosome*. Not to be confused with *biostrome*.

**biosparite** (bi-o-spar'-ite) A limestone consisting of a variable proportion of skeletal debris and

clear calcite (spar). The major organism should be specified when using the term; e.g. "pelecypod biosparite". Cf: *sparite*.

**biospecies** (bi-o-spe'-cies) A species defined on the basis of observed interbreeding capability and potential.

**biosphere** (bi'-o-sphere) 1. All the area occupied by living organisms. It includes parts of the lithosphere, hydrosphere, and atmosphere. Cf: *ecosphere*. 2. All living organisms of the earth.

**biostratigraphic unit** (bi'-o-strat'-i-graph'-ic) A body of strata that is differentiated from adjacent strata by its fossil content or paleontological character. The fundamental unit is the *biozone*.

**biostratigraphic zone** *biozone*.

**biostratigraphy** (bi'-o-stratig'-raphy) Stratigraphy based on the paleontologic aspects of rocks; the differentiation of rock units through study of the fossils they contain.

**biostrome** (bi'-o-strome) A distinctly bedded, blanketlike mass of rock built by and composed mainly of the remains of sedentary organisms, such as a bed of shells, or even a coal seam. Cf: *bioherm*. Not to be confused with *biosome*.

**biota** The animal and plant life of a region; flora and fauna collectively.

**biotic community** (bi-ot'-ic) *community*.

**biotic factor** A factor of a biological nature, such as availability of food, competition between spe-

cies, and predator-prey relationships, that affects the distribution and abundance of species.

**biotite** (bi'-o-tite) A common rock-forming mineral of the mica group:  $K(Mg, Fe+2)_3(Al, Fe+3)Si_3O_{10}(OH)_2$ . It is black in hand specimen, brown or green in thin section, and has perfect basal (001) cleavage.

**biotope** (bi'-o-tope) 1. An area of uniform ecology and organic adaptation; the habitat of a community of animals and plants adapted to its environment. 2. The environment under which an assemblage of plants or animals live or lived.

**bioturbation** (bi'-o-tur-ba'-tion) The churning and stirring of a sediment by organisms.

**biosone** (bi'-o-zone) A general term for any kind of *biostratigraphic unit*; the basic unit in biostratigraphic classification and generally the smallest biostratigraphic unit on which intercontinental or worldwide correlations can be established. Cf. *acme-zone*, *range-zone*. Syn: *biostratigraphic zone*.

**Birch discontinuity** A seismic discontinuity within the earth's mantle at a depth of about 900 km, caused by phase change or chemical change or both.

**birdfoot delta** A delta formed by many levee-bordered distributaries extending seaward and resembling in plan the outstretched claws of a bird; e.g. the Mississippi River delta.

**birdseye limestone** Very fine-

grained limestone containing spots or tubes of crystalline calcite.

**birefringence** (bi-re-frin'-gence) The ability of crystals other than those of the isometric system to split a beam of ordinary light into two beams of unequal velocities; the difference between the greatest and the least indices of refraction of a crystal. Syn: *double refraction*.

**birefringent** (bi-re-frin'-gent) Said of a crystal that displays *birefringence*; such a crystal has more than one *index of refraction*.

**biscuit-board topography** A glacial landscape characterized by a rolling upland on the sides of which are cirques that resemble the bites made by a biscuit-cutter in the edge of a slab of dough, e.g. the Wind River Mountains in Wyoming. It may represent an early or partial stage in glaciation.

**bisector** (bi-sec'-tor) A plane or line of symmetry.

**bisectrix** (bi-sec'-trix) A line that bisects either of the complementary angles between the two optic axes of a biaxial crystal. See also: *acute bisectrix*; *obtuse bisectrix*.

**bliphenoid** (bi-sphic'-noid) *disphenoid*.

**bit** A general term for *drill bit* or *core bit*.

**bitter lake** A *salt lake* whose waters contain in solution a high content of sodium sulfate and lesser amounts of the carbonates and chlorides ordinarily found in salt lakes; a lake whose water has a bitter taste. Examples include

Carson Lake in Nevada and the Great Bitter Lake in Egypt.

**bittern** (bit'-tern) 1. The bitter liquid that remains in saltworks after sea water has evaporated until the salt has crystallized out. 2. A natural solution in evaporite basins that resembles saltwork liquors, especially in its high magnesium content.

**bitumen** (bi-tu'-men) A general name for various solid and semi-solid hydrocarbons that are fusible and are soluble in carbon bisulfide. Petroleum, asphalts, natural mineral waxes, and asphaltites are all considered bitumens.

**bituminous coal** (bi-tu'-mi-nous) Coal that contains more than 14% volatile matter (on a dry, ash-free basis) and has a calorific value of more than 11,500 BTU/lb (moist, mineral-matter-free). It is dark brown to black and burns with a smoky flame. Bituminous coal is the most abundant rank of coal; much is Carboniferous in age. Syn: *soft coal*.

**bivalve** adj. Having a shell composed of two distinct and usually movable parts, equal or subequal, that open and shut. Cf: *univalve*. —n. A bivalve animal, specif. a mollusk of the class Bivalvia (Pelecypoda), including the clams, oysters, scallops, and mussels. See also *pelecypod*.

**blackdamp** A coal-mine gas that is nonexplosive and consists of about 15% carbon dioxide and about 85% nitrogen. Cf: *fire-damp*. Syn: *chokedamp*.

**black diamond** 1. *carbonada*. 2. A

black gem diamond. 3. Dense black hematite that takes a polish like metal. 4. *coal*.

**black granite** A commercial "granite" that when polished is dark gray to black. It may be a diabase, diorite, or gabbro.

**blackjack** 1. A dark-colored variety of sphalerite. 2. A thin stratum of coal interbedded with layers of shale ("slate"); a slaty coal with a high ash content.

**black light** 1. A prospector's and miner's term for ultraviolet light, used in exploration and evaluation to detect mineral fluorescence. 2. An instrument, usually portable, that produces ultraviolet light for this purpose.

**black mud** A type of marine mud whose dark color is due to hydrogen sulfide, developed under anaerobic conditions, a *euxinic* mud.

**black sand** 1. An alluvial or beach sand consisting predominantly of grains of heavy, dark minerals or rocks (e.g. magnetite, rutile, garnet, or basaltic glass), concentrated chiefly by wave, current, or surf action. It may yield valuable minerals. 2. An asphaltic sand.

**blanket deposit** (blan'-ket) 1. A sedimentary deposit of great lateral extent and relatively uniform thickness. 2. A flat deposit of ore of which the length and breadth are relatively great as compared with the thickness. More or less synonymous terms are flat sheets, bedded veins, beds, or flat masses.

**blanket sand** A *blanket deposit* of sand or sandstone of unusually wide distribution, typically an or-

thoquartzitic sandstone deposited by a transgressive sea advancing for a considerable distance over a stable shelf area; e.g. the St. Peter Sandstone of the east-central U.S. Syn: *sheet sand*.

**blasting** Abrasion effected by the impact of fine particles moved by wind or water against a stationary surface; esp sandblasting.

**blastoid** (blas'-toid) A class of stemmed budlike echinoderms with well-developed five-fold radial symmetry Range, Ordovician to Permian.

**blastoporphyrritic** (blas'-to-por'-phy-rit'-ic) Said of a relict texture in a metamorphic rock in which traces of an original porphyritic texture remain.

**blastopneumitic** (blas'-tp-psam-mit'-ic) Said of the texture of a metamorphosed sandstone that contains relicts of the parent rock. **B layer** The seismic region of the earth from the Moravicić discontinuity to 410 km. It is part of a classification of the earth's interior made up of layers A to G. Syn: *low-velocity zone*.

**bleaching clay** Any clay which, in its natural state or after chemical activation, has the capacity for adsorbing coloring matter from oil.

**bleach spot** A greenish or yellowish area in a red rock, developed by the reduction of ferric oxide around an organic particle. Syn: *deoxidation sphere*.

**bleb** A small, usually rounded inclusion of one material in another, as blebs of olivine poikilitically

enclosed in pyroxene.

**bleeding core** In oil-field usage, a core that gives off oil or gas from pores or fractures.

**blende** *sphalerite*.

**blind** Said of a mineral deposit that does not crop out. The term is more appropriate for a deposit that terminates below the surface than for one that is simply hidden by unconsolidated surficial debris.

**blind valley** A valley in *karst* that ends abruptly downstream at the point at which its stream disappears underground.

**blister cone** (blis'-ter) A domelike cone on a lava flow, formed when the cooling crust buckled over a *lava tube*.

**block** 1. An angular rock fragment, more than 256 mm (10 in) in diameter, showing a little or no modification by transporting agents. Cf: *boulder*. 2. A pyroclast, more than 64 mm in diameter, that was ejected in a solid state. 3. A *fault block*.

**block caving** A large-production low-cost method of mining, in which the greater part of the bottom area of a block of ore is undercut, the supporting pillars are blasted away, and the ore caves downward and is removed. As the block caves and settles, the cover follows.

**block diagram** A plane figure representing a rectangular block of the earth's crust in three-dimensional perspective, showing a surface area on top and including at least two vertical cross sec-

tions. The top of the block gives a bird's-eye view of the ground surface, and its sides give the underlying geologic structure.

**block faulting** A type of normal faulting in which the crust is divided into structural or *fault blocks* of different elevations and orientations. It is the process by which *block mountains* are formed

**block field** A thin accumulation of angular blocks, without a cliff or ledge above as an apparent source. Block fields occur on high mountain slopes above treeline, and in polar regions; they are most extensive along slopes parallel to the contour; and they exist on slopes of less than 5°. Cf: *block stream*. Syn: *stone field*.

**block mountain** A mountain that is formed by *block faulting*. Syn: *fault-block mountain*.

**block stream** An accumulation of boulders or angular blocks, usually at the head of a ravine, as a narrow body more extensive downslope than along the slope. Block streams may extend into forests or fill a valley floor; and they may exist on any slope angle, but ordinarily not steeper than 40°. Cf: *block field*. Syn: *rock stream*.

**block stripe** A short, broad *sorted stripe* containing material that is coarser, and of less uniform size, than that in a *stone stripe*.

**bloom** 1. An *efflorescence*. 2. The oxidized or decomposed exposure of a vein or coal bed, esp. the latter. 3. An *algal bloom* or *plankton*

*bloom*.

**blowhole** 1. A nearly vertical hole or fissure in a sea cliff, leading from the inner end of a *sea cave* upward to the surface. Waves and a rising tide force water and compressed air into it, making a geyserlike effect. 2. An opening that passes through a snow bridge into a crevasse, generally characterized by a current of air. 3. A minute gas vent on the surface of a lava flow.

**blowout** 1. A general term for various saucer- or trough-shaped hollows formed by wind erosion on a dune or other sand deposit; the adjoining accumulation of sand derived from the depression, where readily recognizable, is commonly included. See also: *blowout dune*. 2. A term used by prospectors and miners for any surface exposure of strongly altered, discolored rock thought to be associated with a mineral deposit. 3. Expulsion of the drilling fluid from a well being drilled for oil or gas, which may result if the bit encounters an unexpected volume of gas under high pressure.

**blowout dune** An accumulation of sand derived from a *blowout*, particularly if of large size and considerable height above the source area

**blowpipe** A brass tube through which air is blown into a flame from a bunsen burner, in order to produce an intense heat; it is used in simple qualitative analysis of minerals.

**blue asbestos** *crocidolite*.

**blue band 1.** A layer of dense, bubble-free ice in a glacier. **2.** The dark-ribbon effect produced on the surface of a glacier by the exposure of such layers.

**blue ground** The slaty-blue or blue-green kimberlite breccia of the diamond pipes of South Africa, occurring beneath a superficial oxidized covering known as *yellow ground*.

**blue mud** A hemipelagic type of marine mud, the bluish-gray color of which is due to iron sulfides and organic matter.

**bluestone** A commercial name for a building or paving stone of bluish-gray color; specif. a dense fine-grained feldspathic sandstone that splits easily into thin smooth slabs and is extensively quarried near the Hudson River in New York State for use as *flagstone*.

**blue vitriol** *chalcanthite*.

**bluff** A high bank or bold headland, presenting a precipitous front; a steep cliff.

**BM** *bench mark*.

**BOD** *biochemical oxygen demand*.

**boehmite** (boehm'-ite [barne'-ite])

A gray, brown, or reddish orthorhombic mineral,  $AlO(OH)$ , a dimorph of diaspore. It is a major constituent of some bauxites.

**bog 1** Waterlogged, spongy ground, consisting primarily of mosses, containing acidic, decaying vegetation that may develop into peat. **2** The vegetation characteristic of this environment, esp. sphagnum, sedges, and

heaths. Cf: *marsh; swamp*.

**bog burst** The bursting of a bog under the pressure of its swelling, due to water retention by a marginal dam of growing vegetation. The escaping water produces muddy peat that flows over the surrounding area.

**boghead coal** A nonbanded sapropelic coal resembling *cannel coal* in its physical properties but consisting dominantly of algal matter rather than spores. Cf: *urbanite*.

**bog iron ore** A general term for a soft, porous deposit of impure hydrous iron oxides formed in bogs, swamps, and shallow lakes by precipitation from iron-bearing waters and by the oxidizing action of algae, iron bacteria, or the atmosphere. Composed principally of limonite impregnated with plant debris, clay, and clastic material. It is an iron ore of poor quality.

**bog manganese wad.**

**boiling spring 1.** A spring in which the water is agitated by heat. **2.** A spring that flows so rapidly that strong vertical eddies develop.

**bolson** (bol-son') A term applied in the desert regions of SW U.S. to an extensive flat alluvium-floored depression, into which drainage from the surrounding mountains flows toward a central playa; an interior basin, or a basin with internal drainage. Etymol: Spanish, "large purse".

**bomb** *volcanic bomb*.

**bonanza** (bo-nan'-za) A miner's term for a rich body of ore or a rich part of a deposit; a mine is "in



bonanza" when it is operating profitably. Also, discontinuous locally rich ore deposits, esp. epithermal ones. Spanish, "prosperity, success".

**bone bed** Any sedimentary stratum (usually a thin bed of sandstone, limestone, or gravel) in which fossil bones or bone fragments are abundant, and often containing other organic remains, such as scales, teeth, and coprolites.

**bone coal** 1. Coal that has a high ash content. It is hard and compact. 2. Shaly partings in coal, sometimes called *slate*.

**bone phosphate of lime** Tricalcium phosphate,  $\text{Ca}_3(\text{PO}_4)_2$ . The phosphate content of phosphorite may be expressed as percentage of bone phosphate of lime. Abbrev: BPL.

**book structure** In ore deposits, the alternation of ore with gangue, usually quartz, in parallel sheets. Cf. *ribbon*.

**boomer** 1. A marine seismic-energy source in which a high-voltage discharge causes two metal plates to separate abruptly in a body of water. 2. A very strong, usually low-frequency event on a seismic recording.

**booming sand** A *sounding sand*, found on a desert, that emits a low-pitched note of considerable magnitude and duration as it slides (either spontaneously or when induced) down the slip face of a dune.

**borate** (bo'-rate) A mineral compound characterized by a funda-

mental structure of  $\text{BO}_3^{-3}$ . An example is boracite,  $\text{Mg}_3\text{B}_7\text{O}_{13}\text{Cl}$ . Cf: *carbonate*; *nitrate*.

**borax** (bo'-rax) A white, yellowish, or gray mineral:  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ . It is an ore of boron and occurs as a surface efflorescence or in crystalline masses embedded in muds of alkaline lakes. Borax is used in glass, ceramics, agricultural chemicals, pharmaceuticals, and many other products. Syn: *tincal*.

**borderland** A long, relatively narrow land mass adjacent to a North American continental border, which was supposed to have existed during Paleozoic and later time and to have contributed sediment to a geosyncline. The concept is now discredited.

**bore** 1. A wall-like wave of water, with an abrupt front, produced as an incoming tide rushes up a shallow, narrowing estuary or bay. Syn: *tidal bore*. 2. A submarine sand ridge in very shallow water that may rise to intertidal level. 3. A borehole or boring.

**boreal** (bo'-re-al) Pertaining to the north; northern.

**borehole** A circular hole made by boring; esp. a deep hole of small diameter, such as an oil well or a water well.

**bornhardt** (born'-hardt) A large *inselberg*.

**bornite** (born'-ite) A mineral,  $\text{Cu}_5\text{FeS}_4$ , isometric; reddish-brown, readily tarnishing to iridescent blue or purple "peacock ore". An ore of copper.

**bort** 1. A granular aggregate com-

sisting of imperfectly crystallized diamonds. It often occurs as spherical forms, with a radial fibrous structure. 2. A diamond of the lowest quality, so flawed or off-color that it is suitable only for crushing into abrasive powders for industrial use (as for saws and drill bits); an *industrial diamond*. 3. A term formerly used as a syn. of *carbonado*. —Cf: *ballas*.

**boas** 1. A smooth, rounded mound of resistant bedrock, usually bare. 2. A raised, knoblike structure in various foraminifera, echinoids, and gastropods. 3. A *stock*.

**botryoidal** (bot-ry-oi'-dal) Having the form of a bunch of grapes. Said of certain minerals, e.g. hematite and smithsonite. Cf: *colloform*; *reniform*.

**bottom** 1. A lowland, usually highly fertile, along a stream; an alluvial plain. Syn: *bottom land*. 2. The bed of a body of water. 3. The lowest and usually richest part of an alluvial placer; also, the lower limit of an ore body.

**bottom-hole pressure** The pressure produced in a well bore at or near the depth of a reservoir formation. It may be measured as a "flowing bottom-hole pressure", or as *shut-in pressure* to record the rate of pressure build-up during the survey period. Abbrev: BHP. Syn: *reservoir pressure*.

**bottom land** *bottom*.

**bottom load** *bed load*.

**bottomset bed** One of the horizontal or gently inclined layers of sediment deposited in front of the advancing *foreset beds* of a delta.

Syn: *bottomset*.

**boudin** (bou-din') One of a series of sausage-shaped segments occurring in boudinage structure. Etymol: French; "sausage".

**boudinage** (bou-din-age') A structure common in strongly deformed sedimentary and metamorphic rocks, in which an original continuous competent layer or bed between less competent layers has been stretched, thinned, and broken at regular intervals into bodies resembling *boudins* or sausages. Syn: *sausage structure*.

**Bouguer anomaly** (Bou-guer' [Boo-gay']) A gravity value calculated after corrections for latitude, elevation, and terrain. See also. *Bouguer correction*.

**Bouguer correction** An adjustment made in gravity-survey data to allow for elevation of the station and the rock between the station and some level datum, usually sea level.

**boulder** (boul'-der) A detached rock mass larger than a *cobble*, having a diameter greater than 256 mm (10 in.), or about the size of a volleyball, being somewhat rounded or otherwise distinctively shaped by abrasion in the course of transport; the largest rock fragment recognized by sedimentologists.

**boulder clay** An unstratified glacial deposit of silt and clay in which are embedded striated, subangular boulders of various sizes. Cf: *till*.

**boulder pavement** 1. A surface of

boulder-rich till abraded to flatness by glacier movement. 2. An accumulation of glacial boulders once contained in a moraine and remaining nearly in their original positions after removal of finer material by waves and currents. 3. A *desert pavement* consisting of boulders.

**boulder rampart** A narrow ridge of boulders built along the seaward edge of a reef flat, esp. on the side from which the prevailing winds blow. The rampart, which seldom exceeds 1 or 2 m in height, occurs close behind the *lithothamnion* ridge where present.

**boulder train** A line or series of glacial boulders and smaller clasts extending from the same bedrock source, often for many kilometers, in the direction of movement of the glacier by which they were transported and deposited. Cf: *boulder belt*; *boulder fan*.

**boundary monument** (bound'-a-ry) A pile of stones or other material object placed on or near a boundary line, to preserve and identify the location of the line on the ground.

**boundary stratotype** That point in a specific sequence of rock strata that serves as the standard for definition and recognition of a stratigraphic boundary. Cf: *stratotype*.

**boundary tension** A general term used to designate all surface and interfacial tensions at boundary surfaces, such as liquid-gas, liquid-liquid, and liquid-solid.

**boundary wave** A seismic wave

propagated along a free surface or an interface between layers.

**Bowen's reaction series** *reaction series*.

**box canyon** A canyon having steep rock sides and zigzag course, presenting a view from its bottom of being surrounded or "boxed in" by four almost vertical walls.

**box fold** A fold with the approximate profile form of three sides of a rectangle.

**boxwork** A network of intersecting blades or plates of limonite or other minerals, deposited in cavities and along fracture planes from which the intervening material has been dissolved by processes associated with the movement of ground water. Boxworks are common in the oxidized zone of sulfide ores and on the ceilings of caves.

**BPL** *bone phosphate of lime*.

**brachial** (bra'-chi-al) adj. Pertaining to an arm or armlike structure of an animal, such as a starfish or brachiopod.

**brachiopod** (bra'-chi-o-pod) Any marine invertebrate belonging to the phylum Brachiopoda, characterized by two bilaterally symmetrical valves that are commonly attached to a substratum but may also be free. Range, Lower Cambrian to the present. Syn: *brach*; *lamp shell*.

**brachy-axis** (brach'-y-ax'-is) The shorter lateral axis of an orthorhombic or triclinic crystal; it is usually the *a* axis. Cf: *macro-axis*.

**brachydome** (brach'-y-dome) A

first-order prism in the orthorhombic system; it is rhombic, with four faces parallel to the brachy-axis.

**brachygenesis** (brach-y-gen'-e-sis)

The phenomenon in evolution in which part of a presumed recapitulated sequence has evolved out and no longer appears. Cf: *acceleration*.

**brachypinacoid** (brach-y-pun'-a-

coid) Side pinacoid, parallel to the vertical and the shorter lateral axis in an orthorhombic, monoclinic, or triclinic crystal.

**brackish** Said of water with a salinity intermediate between that of normal sea water and that of normal fresh water.

**bradygenesis** (brad-y-gen'-e-sis) *bradytely*.

**bradytely** (brad-y-tel'-y) Retardation in the development of a group of organisms that may gradually cause certain individuals to fall behind the normal rate of progress in some or all of their characteristics. Syn: *bradygenesis*. Etymol: Greek *bradys*, "slow".

**Bragg equation** A statement in crystallography that the X-ray diffractions from a three-dimensional lattice may be thought of as reflecting from the lattice planes:  $n\lambda = 2d \sin\theta$ , in which  $n$  is any integer,  $\lambda$  is the wavelength of the X-ray,  $d$  is the crystal plane separation, also known as d-spacing, and  $\theta$  is the angle between the crystal plane and the diffracted beam, also known as the Bragg angle. Syn: *Bragg's law*.

**Bragg's law** *Bragg equation*.

**braided stream** A stream that divides into an interlacing network of branching and reuniting shallow channels separated from each other by islands or channel bars, resembling in plan the strands of a complex braid; esp. an overloaded and aggrading stream flowing in a wide channel on a flood plain.

Syn: *anastomosing stream*.

**branch fault** *auxiliary fault*.

**branchiopod** (bran'-chi-o-pod)

Any crustacean belonging to the class Branchiopoda, characterized by the similarity of their numerous body segments and limbs and by their filter-feeding mode of nourishment. Range, Lower Devonian to the present.

**Bravais lattice** (Bra-vais') A syn. of *crystal lattice*; it is named for the nineteenth-century French physicist, Auguste Bravais, who demonstrated that there are only 14 possible unique kinds of crystal lattices.

**breached anticline** An anticline that has been deeply eroded in the center, so that it is flanked by erosional scarps facing inward. Cf: *bald-headed anticline*.

**breadcrust bomb** A *volcanic bomb* with a checkered and cracked exterior resulting from expansion of the interior after solidification of the crust.

**break** 1. *arrival*. 2. An irregular or rough piece of ground, e.g. a gorge; often used in the plural. See: *breaks*. 3. A marked or abrupt change in a slope. 4. An abrupt change in lithology or fau-

nal content in a stratigraphic sequence.

**breaker** A wave that has become so steep that the crest outpaces the body of the wave and collapses into a turbulent mass on shore or over a reef or rock. See also: *surf*. Syn: *breaking wave*.

**breaker depth** The still-water depth at the point where a wave breaks.

**breaker height** Average height of breaking waves from trough to crest.

**breaks** 1. A term used in the western U.S. for a tract of rough or broken land dissected by ravines and gullies, as in a badlands region. 2. Any sudden change in topography, as from a plain to hilly country, or a line of irregular cliffs at the edge of a mesa or at the head of a river; e.g. Cedar Breaks, Utah. See also: *break*.

**break thrust** An overthrust fault developed during deformation of an anticline.

**breccia** (brec'-cia [bret'-shia]) A coarse-grained clastic rock, composed of angular broken rock fragments held together by a mineral cement or a fine-grained matrix, e.g. a *collapse breccia*, *fault breccia*, or *volcanic breccia*. Etymol: It., "broken stones, rubble."

**breccia dike** A sedimentary dike composed of breccia injected into the country rock.

**bridal-veil fall** A cataract of great height and such small volume that the falling water is largely dissipated in spray before reaching the lower stream bed. Type

example: Bridalveil Fall in Yosemite Valley, Calif.

**bridge** n. 1. *natural bridge*. 2. Rock fragments that lodge part way down in a drill hole so as to obstruct passage of drilling tools; also, an obstruction placed intentionally in a drill hole. — v. To form a bridge in a drill hole.

**bright coal** A type of *banded coal* consisting of more than 5% of anthraxylon and less than 20% of opaque matter; banded coal in which translucent matter predominates. Cf: *attrital coal*.

**bright spot** An exceptionally strong signal on a seismic profile, often indicating an accumulation of natural gas.

**brimstone** A common or commercial name for *sulfur*, esp. native sulfur or fine sulfur fused into rolls, sticks, or blocks.

**brine** 1. Sea water that, owing to evaporation or freezing, contains more than the usual amount of dissolved salts. 2. Subsurface water with a high content of dissolved salts.

**British thermal unit** A unit of heat which is 1/180 part of that required to raise the temperature of one pound of water from 32°F. to 212°F. at sea level. It is usually considered as that amount of heat required to raise the temperature of one pound of water from 63°F. to 64°F. Abbrev: B.t.u.

**brittle** Said of a rock that fractures at less than 3-5% deformation or strain. Cf: *ductile*.

**brittleness** Property of solid material that ruptures easily with

little or no plastic flow Cf *ductility*.

**bromoform** (bro'-mo-form) Tri-bromethane  $\text{CHBr}_3$  It is used as a *heavy liquid*, its specific gravity is 2.9

**bronzeite** (bronz'-ite) A brown or green variety of *enstatite* containing iron and often having a bronzelike or pearly metallic luster, an orthopyroxene intermediate in composition between enstatite and hypersthene

**brookite** (brook'-ite) A brown, reddish, or sometimes black orthorhombic mineral  $\text{TiO}_2$  It is trimorphous with rutile and anatase, and occurs in druses and cavities Syn *pyromelane*

**brown coal** A low-rank coal, intermediate between peat and lignite, in which original plant structures may usually be seen The term is generally used in Europe, Australia, and Great Britain Cf *lignite*

**brown iron ore** *limonite*

**brownstone** A brown or reddish-brown sandstone whose grains are generally coated with iron oxide, specif a ferruginous quartz sandstone of Triassic age, once extensively quarried in the Connecticut River valley for use as building stone

**brucite** (bru'-cite) A hexagonal mineral  $\text{Mg}(\text{OH})_2$  It commonly occurs in thin pearly folia and in fibrous form, as in serpentine and impure limestone

**Brunton compass** (Brun'-ton) A compact pocket instrument that consists of an ordinary compass,

folding open sights, a mirror, and a rectangular spirit-level clinometer It can be used in the hand or on a staff or light rod for reading horizontal and vertical angles, for leveling, and for reading the magnetic bearing of a line It is used in sketching mine workings, and in preliminary topographic and geologic surveys on the surface Usually called a "Brunton". Syn *pocket transit*

**bryophyte** (bry'-o-phyte) A non-vascular plant that may have differentiated stems and leaves, but that has no true roots Liverworts and mosses are bryophytes Cf *thallophyte*, *pteridophyte*

**bryozoan** (bry-o-zo'-an) Any invertebrate belonging to the phylum Bryozoa and characterized chiefly by colonial growth and a branching, twiglike skeleton Range, Ordovician (or possibly Cambrian) to present Syn *moss animal*, *polyzoan*

**B-tectonite** A tectonite whose fabric is dominated by linear elements Not in common use, having been largely replaced by the term L-tectonite Cf *L-tectonite*, *S-tectonite*

**B.t.u.** *British thermal unit*

**B-type lead** Anomalous lead that gives model ages older than the age of the enclosing rock Cf *J-type lead* Syn *Bleiberg-type lead*

**bubble point** A state of fluids characterized by the coexistence of a liquid phase with an infinitesimal quantity of gas phase in equilibrium

**bubble trend** A planar or linear distribution of bubbles in glacier ice.

**Bubnoff unit** (Bub'-noff) A standard measure of geologic time-distance rates (as for geologic movements and increments), defined as 1 micron/year (1 mm/thousand years, or 1 m/million years). Named in honor of Serge von Bubnoff (1888-1957), Russian-born German geologist.

**buffalo wallow** (buf'-fa-lo) One of the small undrained shallow depressions that were once common on the Great Plains of the western U.S., usually containing water after a rain. It is generally believed to have been modified, and perhaps initially formed, by the trampling and wallowing of buffalo herds in mud and dust. The diameter ranges from about a meter to 15-20 m, and the depth from several centimeters to a few meters.

**buhrstone** (buhr'-stone) A siliceous rock suitable for use as millstones; e.g. an open-textured tough fine-grained sandstone, or a silicified fossiliferous limestone. Syn: *millstone*.

**building stone** A general term for any rock used in construction. See also: *dimension stone*.

**buildup** A nongeneric term for any extra or "stray" limestone bed or beds, in addition to the normal sequence; e.g. a marine bank, a bioherm, or an organic reef.

**bulb glacier** A bulb- or lobe-shaped mass of ice formed where a valley glacier leaves its confin-

ing walls and extends onto an adjacent lowland at the foot of a mountain slope; a bulbous *piedmont glacier*.

**bulk density** The weight of an object or material divided by its volume, including the volume of its pore spaces; specif. the weight per unit volume of a soil mass that has been oven-dried to a constant weight at 105°C. Syn: *apparent density*.

**bulk modulus** A *modulus of elasticity* which relates a change in volume to the hydrostatic state of stress. It is the reciprocal of *compressibility*. Syn: *volume elasticity*; *modulus of incompressibility*.

**Bullard discontinuity** (Bul'-lard) The seismic-velocity interface between the *outer core* and the *inner core*.

**bullion** (bul'-lion) 1. A concretion found in some types of coal. It is composed of carbonate or silica, stained brown by humic derivatives, and may be several centimeters to a meter or more in diameter. Well-preserved plant structures often form the nucleus. Cf: *coal ball*. 2. A nodule of clay, shale, ironstone, or pyrite that generally encloses a fossil.

**bull quartz** A miner's or prospector's term for white massive barren quartz.

**buoyancy** (buoy'-an-cy) The resultant of upward forces, exerted by the water on a submerged or floating body, equal to the weight of the water displaced by this body.

**buried hill** A hill consisting of re-

sistant older rock over which later sediments were deposited.

**barrow** A cylindrical or near-cylindrical tube, often filled with clay or sand, which may lie along a bedding plane or penetrate a rock, made by an animal that lived in the soft sediment.

**barrow porosity** Porosity in a sedimentary rock that results from the work of burrowing organisms.

**butane** (bu'-tane) A gaseous inflammable paraffin hydrocarbon, formula  $C_4H_{10}$ , which occurs in petroleum and natural gas.

**butte** (bewt) 1. A conspicuous isolated flat-topped hill with steep slopes or precipitous cliffs, often capped with a resistant layer of rock and bordered by talus, and representing an erosion remnant carved from flat-lying rocks; the summit is smaller in extent than that of a *mesa*. 2. An isolated hill having steep sides and a craggy, rounded, or pointed summit; e.g. a volcanic cone (as Mount Shasta, Calif., formerly known as Shasta

Butte).—Etymol: French, "knoll, hillock."

**buttress sand** (but'-tress) A sandstone that intersects an underlying surface of unconformity, as on the flank of a buried hill or a truncated anticline. It often forms a trap for oil.

**b.y.** *billion years*.

**bypassing** Sedimentary transport across areas of nondeposition, as where one particle size passes another that is being simultaneously transported, or continues in motion after the other has come to rest; e.g. the normal decrease in average particle size of sediments away from a source area.

**bysmalith** (bys'-ma-lith) A roughly vertical cylindrical igneous intrusion, bounded by steep faults. It has been interpreted as a type of *laccolith*.

**bytowntite** (by'-town-ite) A bluish to dark-gray mineral of the plagioclase feldspar group with composition ranging from  $Ab_{30}An_{70}$  to  $Ab_{10}An_{90}$ . It occurs in basic and ultrabasic igneous rocks



## C

**cable tools** The equipment used in the standard or cable-tool method of drilling. It consists essentially of a steel bit with a chisel-shaped cutting edge. In drilling, the tools are alternately lifted and dropped, the rock being cut by repeated blows of the bit. Broken chips of rock are removed by a *bailer*.

**cadastral survey** (ca-das'-tral) A survey relating to land boundaries and subdivisions, made to create units suitable for transfer or to define limitations of title; esp. a survey of the public lands of the U.S., such as one made to identify or restore property lines.

**cafemic** (ca-fem'-ic) A mnemonic term applied to an igneous rock or magma that contains calcium, iron, and magnesium.

**calamine** (cal'-a-mine) 1. A term used in the U.S. for *hemimorphite* and in Great Britain for *smithsonite*. 2. *hydrozincite*. 3. A commercial term for the oxidized ores of zinc, as distinguished from the sulfide ores.

**calaverite** (cal-a'-ver-ite) A pale bronze-yellow or tin-white monoclinic mineral:  $\text{AuTe}_2$ . It often contains silver, and is an important source of gold.

**calc-** A prefix meaning limy, i.e., containing calcium carbonate.

**calc-alkalic series** (calc-al'-ka-lic)

1. Those igneous rocks in which the weight percentage of silica is between 56 and 61 when the weight percentages of  $\text{CaO}$  and of

$\text{K}_2\text{O} + \text{Na}_2\text{O}$  are equal. Cf: *calcic series*. 2. Those igneous rocks containing plagioclase feldspar.

**calcareenite** (cal-car'-e-nite) A limestone, more than half of which consists of cemented sand-size grains of calcium carbonate; a consolidated calcareous sand.

**calcareous** (cal-car'-e-ous) Containing calcium carbonate. When applied to a rock name, it implies that as much as 50% of the rock is calcium carbonate.

**calcareous algae** A group of algae that remove calcium carbonate from the shallow water in which they live and deposit it as a more or less solid calcareous structure.

**calcareous ooze** A deep-sea pelagic sediment containing at least 30% calcareous skeletal remains, e.g. pteropod ooze. Cf: *siliceous ooze*.

**calcareous tufa** *tufa*.

**calci-clastic** (cal-ci-clas'-tic) Pertaining to a clastic carbonate rock.

**calcic series** (cal'-ic) Those igneous rocks in which the weight percentage is greater than 61 when the weight percentages of  $\text{CaO}$  and of  $\text{K}_2\text{O} + \text{Na}_2\text{O}$  are equal. Cf: *calc-alkalic series*.

**calcification** (cal'-ci-fi-ca'-tion) Replacement of the original hard parts of an animal or plant by calcium carbonate.

**calcify** (cal'-ci-fy) To make or become hard or stony by the deposit of calcium salts.

**calclutite** (cal-ci-lut'-ite) A limestone, more than half of which consists of detrital calcate particles of silt and/or clay size; a con-

consolidated calcareous mud Cf *calcisiltite*.

**calcimicrite** (cal-ci-mic'-rite) A limestone in which the particles have diameters less than 20 microns and the micrite component exceeds the allochem component. See also *micritic limestone*.

**calcination** (cal-ci-na'-tion) The heating of a substance to its temperature of dissociation, e.g. of limestone to  $\text{CaO}$  and  $\text{CO}_2$  or of gypsum to lose its water of crystallization.

**calcirudite** (cal-ci-rud'-ite) A limestone, more than half of which consists of detrital calcite particles larger than sand size and often cemented with calcareous material, a consolidated calcareous gravel or rubble, or a limestone conglomerate or breccia.

**calcisiltite** (cal-ci-sil'-tite) A limestone consisting predominantly of detrital calcite particles of silt size, a consolidated calcareous silt Cf *calcilutite*.

**calcite** (cal'-cite) A common rock-forming mineral,  $\text{CaCO}_3$ . Commonly white or gray, it has perfect rhombohedral cleavage and reacts readily with cold dilute hydrochloric acid. Calcite is the chief constituent of limestone and most marble.

**calcitic dolomite** (cal-cit'-ic) A dolomite rock in which calcite is conspicuous, but the mineral dolomite is more abundant, specifically a dolomite rock containing 10-50% calcite and 50-90% dolomite Cf *dolomitic limestone*.

**calcium bentonite** (cal'-ci-um)

Bentonite in which  $\text{Ca}^{++}$  is the dominant exchangeable ion. Calcium bentonites swell little more than ordinary clays but are highly adsorbent and also useful in bleaching and decolorizing Cf *sodium bentonite*.

**calcium carbonate** A solid,  $\text{CaCO}_3$ , occurring in nature chiefly as the minerals calcite and aragonite.

**calcrete** (cal-crete') 1 A conglomerate consisting of surficial sand and gravel cemented into a hard mass by calcium carbonate precipitated from solution by infiltrating waters, or deposited by the escape of carbon dioxide from vadose water. 2 A calcareous *duricrust*, *caliche* —Etymol. *calcareous* + *concrete* Cf *silcrete*.

**calc-schist** A metamorphosed argillaceous limestone with a schistose structure.

**calc-silicate rock** A metamorphic rock consisting mainly of calcium-bearing silicates such as diopside and wollastonite, and formed by metamorphism of impure limestone or dolomite. Syn *lime-silicate rock*.

**calc-sinter** (calc-sin'-ter) *travertine*.

**caldera** (cal-der'-a) A large basin-shaped volcanic depression, more or less circular, the diameter of which is many times greater than that of the included vent or vents, irrespective of steepness of the walls or form of the floor. See also *explosion caldera*, *collapse caldera*.

**caldera complex** The diverse rock

assemblage underlying a caldera, comprising dikes, sills, stocks, and vent breccias; craterfills of lava, talus beds of tuff, cinder, and agglomerate; fault gouge and fault breccias, talus fans along fault escarpments, cinder cones, and other products formed in a caldera.

**Caledonian orogeny** (Cal-e-do'-ni-an) A name commonly used for the early Paleozoic deformation in Europe which created an orogenic belt, the Caledonides, extending from Ireland and Scotland northeastward through Scandinavia.

**Caledonides** (Cal-e-do'-ni-des) The orogenic belt extending from Ireland and Scotland northwestward through Scandinavia, formed by the early Paleozoic Caledonian orogeny.

**calf** A piece of floating ice, esp. one that has broken away from the submerged part of an iceberg.

**caliche** (ca-li'-che) 1 Gravel, soil, or alluvium cemented with sodium salts in the nitrate deposits of the Atacama Desert of Chile and Peru. 2 A term used in Peru for a thin layer of clayey soil capping a gold vein in Chile for a whitish clay in the selvage of veins, in Mexico for feldspar or white clay, in Colombia for a recently discovered mineral vein, or, in placer mining, a bank composed of clay, sand, and gravel. 3 In Mexico and southwest U.S., gravel, sand, or desert debris cemented by porous calcium carbonate, also the calcium carbonate itself. See also

*dunecrust; calcrete*

**caliper log** (cal'-i-per) A well log that shows the variations with depth in the diameter of an uncased borehole. It is produced by spring-activated arms that measure the varying widths of the hole as the device is drawn upward.

**calorific value** (cal-o-rif'-ic) For solid fuels and liquid fuels of low volatility, the amount of heat produced by combustion of a specified quantity under specified conditions.

**calving** (calv'-ing) The breaking away of a mass of ice from a glacier, an ice shelf, or an iceberg, the process of iceberg formation.

**calyx** (ca'-lyx) 1 The upper part of a corallite in which a coral polyp sits. 2 The plated structure of an echinoderm body, excluding the stem and arms.

**camber** (cam'-ber) A superficial structure in areas of flat-lying rocks, formed where weak strata beneath a more competent bed flow laterally, as into a valley, allowing the competent bed to sag and "dip" along the edges of its outcrop.

**Cambrian** (Cam'-bri-an) The earliest period of the Paleozoic era, thought to have covered the span of time between 570 and 500 million years ago, also, the corresponding system of rocks. It is named after Cambria, the Roman name for Wales, where rocks of this age were first studied. See also *age of marine invertebrates*.

**camouflage** (cam'-ou-flage) Substitution in a crystal lattice of a trace

element for a common element of the same valence, e.g., Ga for Al. The trace element is then said to be camouflaged by the common element. Cf: *capture*.

**Campbell's law** The general law of migration of drainage divides, which states that the divide tends to migrate toward an axis of uplift or away from an axis of subsidence. Where two streams that head opposite to each other are affected by an uneven lengthwise tilting movement, that one whose declivity is increased cuts down vigorously and grows in length headward at the expense of the other. If the tilting that affects them is part of a general uplift, the divide migrates toward the axis of uplift.

**camptonite** (camp'-ton-ite) A *lamprophyre* composed essentially of plagioclase (usually labradorite) and brown hornblende (usually barkevikite).

**canada balsam** (can'-a-da) A natural cement used in mounting specimens for microscopic analysis; it is exuded as a viscous, yellow-green oleoresin by the balsam fir tree.

**Canadian** (Ca-na'-di-an) Lower Ordovician of North America.

**canal** 1. An artificial watercourse cut through a land area for navigation, drainage, or irrigation. 2. A long narrow arm of the sea connecting two larger stretches of water; usually extending far inland. 3. A cave passage partly filled with water. 4. A hollow vessel, passage, or groove in an in-

vertebrate animal.

**cannel coal** (can'-nel) A variety of bituminous coal of uniform and compact fine-grained texture, generally nonbanded, that consists dominantly of spores. It has a dull to waxy luster and a conchoidal fracture. It is attrital, high in volatiles, ignites easily, and burns with a luminous smoky flame. Cf: *boghead coal*; *torbanite*.

**cannel shale** A black shale formed by the accumulation of sapropels accompanied by a considerable quantity of inorganic material, chiefly silt and clay.

**canyon** (can'-yon) A stream-cut chasm or gorge, the sides of which are composed of cliffs or a series of cliffs rising from its bed. Canyons are characteristic of arid or semiarid regions where downcutting by streams greatly exceeds weathering. Sometimes spelled cañon. See also: *submarine canyon*.

**capable fault** (ca'-pa-ble) A fault defined by the Nuclear Regulatory Commission as one that is "capable" of "near future" movement; in general, a fault on which there has been movement within the last 35,000 years. The definition was developed for use in the siting of nuclear power plants. Cf: *active fault*.

**capacity** (ca-pac'-i-ty) 1. The ability of a current of water or wind to transport detritus, as measured by the quantity it can carry past a given point in a unit of time. Cf: *competence*. 2. The ability of a

soil to hold water. 3. The yield of a pump, well, or reservoir.

**cape** A relatively extensive land area jutting seaward from a continent or large island; a projecting point (e.g. Cape Hatteras, N.C.) or peninsula (e.g. Cape Cod, Mass.)

**capillarity** (cap-il-lar'-i-ty) The action or condition by which a fluid, such as water, is drawn up in small interstices or tubes as a result of surface tension.

**capillary** (cap'-il-lar-y) 1. Said of a mineral that forms hairlike or threadlike crystals, e.g. millerite. 2. Said of tubes or interstices with such small openings that they can retain fluids by *capillarity*.

**capillary conductivity** The ability of an unsaturated soil or rock to transmit water or another liquid. For water, it increases with the moisture content, from zero in a dry material to a maximum equal to the *permeability coefficient*.

**capillary fringe** The lower subdivision of the *zone of aeration*, immediately above the water table, in which the interstices are filled with water under pressure less than that of the atmosphere, being continuous with the water below the water table but held above it by surface tension. Syn: *zone of capillarity*.

**capillary interstice** An opening small enough to hold water by surface tension at an appreciable height above a free water surface. Cf: *subcapillary interstice*; *super-capillary interstice*.

**capillary migration** The movement

of water by capillarity. Syn: *capillary flow*; *capillary movement*.

**capillary pressure** The difference in pressure across the interface between two immiscible fluid phases jointly occupying the interstices of a rock. It is due to the tension of the interfacial surface, and its value depends on the curvature of that surface.

**capillary water** 1. Water held in, or moving through, small interstices or tubes by capillarity. The term is considered obsolete by the Soil Science Society of America. 2. Water of the *capillary fringe*.

**cap rock** 1. In a *salt dome*, a body of anhydrite and gypsum, with minor calcite and sometimes sulfur, that overlies the salt body, or plug. 2. A comparatively impervious stratum immediately overlying an oil- or gas-bearing rock.

**capture** (cap'-ture) 1. Substitution in a crystal lattice of a trace element for a common element of lower valence, e.g., Ba<sup>++</sup> for K<sup>+</sup>. Cf. *camouflage*. 2. *piracy*.

**carapace** (car'-a-pace) A bony or chitinous case covering the dorsal part of an animal.

**carat** (car'-at) A unit of weight for diamonds, pearls, and other gems. The metric carat, equal to 0.2 gram or 200 mg, is standard in the principal countries of the world. Not to be confused with *karat*.

**carbide** (car'-bide) A mineral compound that is a combination of carbon with a metal. An example is cohenite, (Fe,Ni,Co)<sub>3</sub>C.

**carbonaceous** (car-bo-na'-ceous)

1. Said of a rock or sediment that is rich in carbon; coaly. 2. Said of a sediment containing organic matter.

**carbonado** (car-bo-na'-do) An opaque aggregate composed of minute diamond particles, forming a mass with granular structure and superior toughness. It is used as an *industrial diamond*. Cf: *bort*; *ballas*. Syn: *black diamond*.

**carbonate** (car'-bon-ate) 1. A mineral compound characterized by a fundamental anionic structure of  $\text{CO}_3^{2-}$ . Calcite and aragonite,  $\text{CaCO}_3$ , are examples of carbonates. Cf: *borate*; *nitrate*. 2. A sediment formed of the carbonates of calcium, magnesium, and/or iron, e.g. limestone and dolomite.

**carbonation** (car-bon-a'-tion) 1. A process of chemical weathering involving the transformation of minerals containing calcium, magnesium, potassium, sodium, and iron into carbonates or bicarbonates of these metals by carbon dioxide contained in water. Syn: *carbonatization*. 2. Introduction of carbon dioxide into a fluid.

**carbonatite** (car-bon'-a-tite) A carbonate rock of apparent magmatic origin, generally associated with *kimberlites* and alkalic rocks. Carbonatites have been variously explained as derived from magmatic melt, solid flow, hydrothermal solution, and gaseous transfer. A carbonatite may be calcitic or dolomitic.

**carbon dioxide** A colorless, odorless, nonpoisonous gas,  $\text{CO}_2$ , that is a normal part of the ambient

air.

**Carboniferous** (Car-bon-if'-er-ous)

The Mississippian and Pennsylvanian periods combined, ranging from about 345 to about 280 million years ago; also, the corresponding system of rocks. In European usage, the Carboniferous is considered as a single period and is divided into upper and lower parts. The Permian is sometimes included. See also: *age of amphibians*; *age of coal*.

**carbonization** (car'-bon-i-za'-tion)

1. In the coalification process, the accumulation of residual carbon by the progressive changes undergone in organic matter and decomposition products. 2. The slow decay under water of organic material, plant or animal, resulting in a concentration of carbon as a film showing more or less distinctly the form and structure of the original tissue. 3. The conversion into carbon of a carbonaceous substance by driving off the other ingredients, as in the charring of wood.

**carbon monoxide** A colorless, odorless, highly toxic gas,  $\text{CO}$ , that is a major air pollutant and a normal byproduct of the incomplete combustion of fossil fuels.

**carbon ratio** 1. The ratio of the fixed carbon in a coal to the fixed carbon plus the volatile hydrocarbons. 2. The ratio of the most common carbon isotope ( $\text{C}^{12}$ ) to either of the less common isotopes ( $\text{C}^{13}$  or  $\text{C}^{14}$ ), or the reciprocal of one of these ratios. If unspecified, the term generally refers to the

ratio ( $C^{12}/C^{13}$ )

**carbon-ratio theory** The hypothesis that in any region the specific gravity of oil varies inversely with the carbon ratio of the associated coals. As the percentage of fixed carbon in the coal increases as a result of metamorphism, the oil becomes lighter, i.e. higher in volatile hydrocarbons.

**carbon-14** A heavy radioactive isotope of carbon having a mass number of 14 and a half-life of  $5730 \pm 40$  years. (The figure  $5568 \pm 30$  is also used) It is produced in nature by the reaction of atmospheric nitrogen with neutrons produced by cosmic-ray collisions, and artificially by atmospheric nuclear explosions. Carbon-14 is useful in dating and tracer studies of materials directly or indirectly involved with the earth's carbon cycle during the last 50,000 years. Symbol.  $^{14}C$ . Partial syn: *radiocarbon*.

**carbon-14 dating** A method of determining an age in years by measuring the concentration of carbon-14 remaining in an organic material, usually formerly living matter. It is based on the assumption that assimilation of carbon-14 ceased abruptly on the death of an organism and that it thereafter remained a closed system. The method is useful in determining ages in the range of 500 to 30,000 or 40,000 years.

**Carborundum** (Car-bo-run'-dum) Trade name for a synthetic substance (silicon carbide) used as an abrasive and as a refractory

material. It is identical with the mineral moissanite.

**cardinal** (car'-di-nal) adj. Pertaining to the hinge of a bivalve shell.—n. A cardinal part; e.g. a cardinal tooth.

**Carlsbad twin** (Carls'-bad) A type of crystal twinning common in feldspar, especially orthoclase. It is a penetration twin in which the twinning axis is the *c* crystallographic axis and the composition surface is irregular.

**canallite** (car'-nall-ite) A milk-white to reddish orthorhombic mineral:  $KMgCl_3 \cdot 6H_2O$ . It occurs as a saline residue and is a raw material of fertilizer manufacture in some European districts.

**carnelian** (car-nel'-i-an) A translucent red or orange-red variety of chalcedony, containing iron impurities. It is used for seals and signet rings.

**carnivore** (car'-ni-vore) An organism that nourishes itself mainly by feeding on other animals, living or dead. Adj: *carnivorous*. Cf: *herbivore*.

**carnotite** (car'-no-tite) A strongly radioactive, canary-yellow to greenish-yellow secondary mineral:  $K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$ . An ore of uranium and vanadium, it occurs as a powdery incrustation or in loosely coherent masses, chiefly in sandstone (as in the western U.S.).

**Carolina bay** (Car-o-li'-na) Any of various ovate depressions, generally marshy, of a type occurring abundantly on the coastal plain from southern New Jersey to

Florida. Their origin has been attributed to meteorites, upwelling springs, eddy currents, and solution.

**Carrara marble** (Car-ra'-ra) A general name for the marbles quarried near Carrara, Italy. The prevailing colors are white to bluish, or white with blue veins. A fine grade of statuary marble is included.

**cartography** (car-tog'-ra-phy) 1. The science and art of constructing maps and charts, from surveying of the ground to the final printing of the map. 2. The study of maps as scientific documents and works of art.

**cascade** (cas-cade') 1. A series of small closely spaced waterfalls or steep rapids. 2. A bed that buckles into a series of recumbent folds as it slides down the flanks of an anticline under gravity.

**Cascadia** (Cas-ca'-di-a) One of the *borderlands* proposed by Schuchert, in this case along the western margin of North America, partly at sea, partly inland. Most of the evidence adduced for the existence of Cascadia is now otherwise interpreted. Possibly there were minor offshore lands in places, and some former continental material may have disappeared by underthrusting at the edge of the continent, but the foundering of extensive lands into the Pacific Ocean basin is not considered a tenable concept.

**case-hardening** The process by which the surface of a porous rock, especially sandstone or tuff,

is coated by a cement or *desert varnish*, formed by evaporation of mineral-bearing solutions.

**casing** Heavy metal pipe, lowered into a bore hole during or after drilling and cemented into place. It prevents the sides of the hole from caving, prevents loss of drilling mud or other fluids into porous formations, and prevents unwanted fluids from entering the hole.

**casing-head gas** Unprocessed natural gas produced from a reservoir containing oil. Such gas contains gasoline vapors and is so called because it is usually produced under low pressure through the casing head of an oil well.

**cassiterite** (cas-sit'-er-ite) A brown or black tetragonal mineral:  $\text{SnO}_2$ . It is the principal ore of tin. See also: *wood tin*; *stream tin*.

**cast** 1. Secondary rock or mineral matter that fills a *natural mold*, producing a replica of a fossil shell or skeleton. 2. A sedimentary structure representing the infilling of an original mark or depression made on top of a soft bed and preserved as a solid form on the underside of the overlying bed, e.g. a *flute cast* or *load cast*.

**casting** 1. Something that is cast out or off, esp. a worm casting or a *fecal pellet*. 2. The configuration of a surface characterized by sedimentary casts, e.g. "load casting".

**cataclasis** (cat-a-clas'-is) Rock deformation accomplished by fracture and rotation of mineral



grains or aggregates; crushing and granulation. See also: *cataclasite*.

**cataclasite** (cat-a-clas'-ite) A metamorphic rock produced by *cataclasis*, e.g. a tectonic breccia.

**cataclastic** (cat-a-clas'-tic) Pertaining to the structure produced in a rock by the action of severe mechanical stress during dynamic metamorphism; characteristic features include the bending, breaking, and granulation of the minerals. Also, said of the rocks exhibiting such structures. See also: *mortar structure*.

**cataclysm** (cat'-a-clysm) Any geologic event that produces sudden and extensive changes in the earth's surface; e.g. an exceptionally violent earthquake. Adj: *cataclysmic*; *cataclysmal*. Cf: *catastrophe*.

**catanorm** (cat'-a-norm) Theoretical calculation of minerals in a metamorphic rock of the *katazone*, as indicated by chemical analyses. Cf: *mesonorm*; *epinorm*.

**cataract** (cat'-a-ract) 1. A waterfall, usually of great volume, in which the vertical descent is concentrated in one sheer drop. Cf: *cascade*. 2. A series of steep rapids in a large river, e.g. the Nile. 3. An overwhelming rush of water; a flood.

**catastrophe** (ca-tas'-tro-phe) A sudden, violent disturbance of nature, ascribed to exceptional or supernatural causes, affecting the physical conditions and the inhabitants of the earth's surface; e.g. the Noachian flood, or an ex-

tinguishment of an entire fauna. Cf: *cataclysm*.

**catastrophism** (ca-tas'-tro-phism) 1. The doctrine that sudden violent, short-lived, more or less worldwide events outside our present experience or knowledge of nature have greatly modified the earth's crust. 2. The doctrine that the present configuration of the earth's crust, as well as the distribution of living beings, is mainly the result of "a great and sudden revolution" (Cuvier) of 5000 or 6000 years ago, and by extension that geologic processes of the past were of much greater intensity than those of the present. 3. The doctrine that changes in the earth's fauna and flora are explained by recurring catastrophes, followed by creation of different organisms.—Cf: *uniformitarianism*.

**catenone** (cat'-a-zone) *katazone*.

**catchment area** (catch'-ment) 1. As applied to an aquifer, the recharge area and all areas that contribute water to it. 2. The paved or waterproofed area of a storage reservoir. 3. *drainage basin*.

**catchment basin** *drainage basin*.

**catena** (ca-te'-na) 1. A chain of craters on Mars. Most are thought to be of volcanic origin. 2. A sequence of soils of about the same age, derived from similar parent material under similar climatic conditions, but having different characteristics owing to differences in relief and drainage.

**cation** (cat'-i-on) An ion that bears

a positive charge.

**cation exchange base exchange.**

**catlinite** (cat'-lin-ite) A red indurated clay from the upper Missouri River valley region (SW Minnesota), formerly used by the Dakota Indians for making tobacco pipes; a *pipestone*.

**catoctin** (ca-toc'-tin) A residual knob, hill, or ridge of resistant material rising above a peneplain and preserving on its summit a remnant of an older peneplain. Named after Catoctin Mountain, Maryland & Virginia Cf: *monadnock*.

**cat's-eye** A greenish, chatoyant variety of chrysoberyl.

**cauldron subsidence** (caul'-dron)

1. A structure resulting from the lowering along a steep ring fracture of a more or less cylindrical block into a magna chamber; usually associated with ring dikes. In surface cauldron subsidence the ring fracture penetrates the surface of the earth; in underground cauldron subsidence it does not. 2. The process of forming a cauldron subsidence.

**cave** 1. A natural cavity, recess, chamber, or series of chambers and galleries beneath the surface of the earth, large enough for a person to enter. Cf: *cavern*. 2. Informally, any natural rock shelter. e.g. a cliff overhang. 3. *sea cave*.

**cave breccia** Angular fragments of limestone that have fallen to the floor from the roof and sides of a cave and that are cemented with calcium carbonate or occur in a

matrix of cave earth. See also: *collapse breccia*; *solution breccia*.

**cave coral** A rough, knobby cave deposit of calcite that resembles coral in shape.

**cave earth** Deposits of clay, silt, sand, or gravel flooring or filling a cave passage. In a more restricted sense, cave earth includes only the finer fractions. Syn: *fill*.

**cave ice** Ice formed in a cave by natural processes.

**cave marble** *cave onyx*.

**cave onyx** A compact banded deposit of calcite or aragonite found in caves, capable of taking a high polish, and resembling true onyx in appearance. See also: *dripstone*; *flowstone*; *onyx marble*; *travertine*. Syn: *cave marble*.

**cave pearl** A smooth, rounded concretion of calcite or aragonite, formed by precipitation of concentric layers around a nucleus and characterized by radial crystal structure.

**caver** One who engages in cave exploration as a hobby. Syn: *spelunker*. See also: *speleologist*.

**cavern** (cav'-ern) A syn. of *cave*, with the implication of large size; a system or series of caves or cave chambers.

**cavernous** (cav'-ern-ous) Containing caverns, cells, or coarse pore spaces; as in limestones and cellular volcanic rocks.

**cave system** 1. A group of caves that are connected or hydrologically related. 2. A complex cave. Syn: *cavern system*.

**cavity** (cav'-i-ty) 1. A solutional hollow in a limestone cave. 2. A

small hollow in cavernous lava.

**c axis** 1. One of the crystallographic axes used for reference in crystal description. It is oriented vertically. 2. In deformed rocks, e.g. in simple shear, the *c* axis lies in the unique symmetry plane and normal to the movement plane. In progressive simple shear it lies normal to the shear plane. See also: *a* axis; *b* axis.

**cay** A small, low coastal island or emergent reef of sand or coral; a flat mound of sand and admixed coral fragments, built up on a reef flat at or just above high-tide level. Term is used esp. in the West Indies where it is pronounced "key". Etymol: Spanish *cayo*, "shoal or reef". Cf: *key*.

**Cayugan** (Ca-yu'-gan) Upper Silurian of North America.

**CDP** *common depth point*.

**celestite** (cel-es'-tite) An orthorhombic mineral,  $\text{SrSO}_4$ . The principal ore of strontium.

**cellular** (cel'-lu-lar) Said of the texture of a rock characterized by openings or cavities, which may or may not be connected. The term is usually applied to cavities larger than pores and smaller than caverns. The syn. *vesicular* is preferred when describing igneous rocks. Cf: *porous*; *cavernous*.

**Celsius scale** (Cel'-si-us) A thermometric scale, proposed in 1742 by Anders Celsius, with  $0^\circ$  as the melting point of ice and  $100^\circ$  as the boiling point of water. Formerly termed the *centigrade scale*.

**cement** (ce-ment') 1. Chemically

precipitated mineral material that occurs in the spaces among the grains of a sedimentary rock, thus binding the grains into a rigid mass. The most common cements are silica, carbonates, and iron oxides. 2. Ore minerals, e.g. gold, that are a part of, or have replaced, mineral cement. 3. A manufactured gray powder which when mixed with water makes a plastic mass that will "set" or harden. See also: *portland cement*; *concrete*.

**cementation** (ce-men-ta'-tion) The process by which clastic sediments are converted into rock by precipitation of a mineral *cement* among the grains of the sediment. **cement rock** Any rock that is capable of furnishing cement when processed, with little or no addition of other material; specif. a clayey limestone that contains alumina, silica, and lime in approximately the required proportions.

**cenote** (ce-no'-te) In Yucatán, Mexico, a vertical shaft in limestone, open to the surface, that contains standing water. Etymol: Mayan, *tzonot*.

**Cenozoic** (Ce-no-zo'-ic) The latest of the four eras into which geologic time is divided; it extends from the close of the Mesozoic Era, about 65 million years ago, to the present. The Cenozoic Era is subdivided into Tertiary and Quaternary periods, or, on a different basis, into Paleogene and Neogene periods. Syn: *Cainozoic*. See also: *age of mammals*.

**center line** (cen'-ter) A line that continuously bisects a feature (such as a stream, a strip of land, or the bubble tube in a spirit level); specif. the line connecting opposite corners of a quarter section or quarter-quarter section, or the line extending from the true center point of overlapping aerial photographs through each of the transposed center points.

**center of gravity** That point in a body or system of bodies through which the resultant attraction of gravity acts when the body or system is in any position; that point from which the body can be suspended or poised in equilibrium in any position.

**center of instrument** The point on the vertical axis of rotation (of a surveying instrument) that is at the same elevation as that of the collimation axis when that axis is in a horizontal position. It is at or near the intersection of the horizontal and vertical axes of the instrument.

**center of symmetry** A point within an object through which any straight line extends to similar points on the object at equal distances in opposite directions.

**centigrade scale** (cen'-ti-grade) *Celsius scale*.

**central eruption** (cen'-tral) Ejection of debris and lava flows from a central point, forming a more or less symmetrical *volcano*.

**central meridian** The line of longitude at the center of a map projection; the meridian about which the geometric properties of a map

projection are symmetric and which is a straight line on the map. It is used to determine the directions of axes of plane coordinates. See also: *principal meridian*.

**centrifugal replacement** (cen-trif'-u-gal) Mineral replacement in which the host mineral is replaced from its center outward. Cf: *centripetal replacement*.

**centripetal replacement** (cen-trip'-e-tal) Mineral replacement in which the host mineral is replaced from its periphery inward. Cf: *centrifugal replacement*.

**centrosphere** (cen'-fro-sphere) The central core of the earth, composed of heavy material and making up most of its mass. Syn: *barysphere*.

**cephalon** (ceph'-a-lon) The anterior region or head of a trilobite or crustacean. Pl: *cephala*. Etymol: Greek, "head".

**cephalopod** (ceph'-a-lo-pod) A marine mollusk of the class Cephalopoda, characterized by a head surrounded by tentacles and, in most fossil forms, by a straight, curved, or coiled calcareous shell divided into chambers by transverse septa. Range, Cambrian to present.

**ceratite** (cer'-a-tite) Any ammonoid belonging to the order Ceratitida, characterized by a shell having sutures with serrate lobes and, in some groups, by an ornamented shell. Range, Permian to Triassic.

**cerussite** (ce-rus'-site) A mineral,  $PbCO_3$ , a member of the arago-

nite group. Orthorhombic. An ore of lead, commonly formed by the oxidation of galena.

**cf.** 1. Used in paleontology to indicate that a specimen is very closely comparable to, but not certainly the same as, those of a named species; it implies more certain similarity than *aff.* 2. Used in this dictionary and other reference works to mean "compare".--Etymol: Latin *conferre*, "to compare".

**cfs** Cubic feet per second, a measure of the amount of water passing a given point

**chain** 1. The legal unit of length for the survey of public lands of the United States. The chain is the equivalent of 20.13 m. The name is derived from Edmund Gunter's chain, which was a series of links connected by rings. The advantage in measuring in chains is that 10 sq chains = 1 acre. 2. Any series of related or similar natural features, e.g. chain of mountains, islands, or lakes

**chain coral** A colonial coral (esp. one belonging to the family Halysitidae) characterized, in plan view, by cylindrical, oval, or subpolygonal corallites joined together on two or three sides to form a branching, chainlike network.

**chaining** (chain'-ing) A term that was applied originally to measuring distances on the ground by means of a surveyor's chain, but later to the use of either a chain or a tape. The term "chaining" is now preferred (for historical and

legal reasons) for surveys of the U.S. public-lands system and "taping" for all other surveys.

**chain silicate** *inosilicate*.

**chalcantite** (chal-can'-thite [kal-can'-thite]) A blue triclinic mineral:  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ . It is a minor ore of copper. Syn. *blue vitriol*.

**chalcedony** (chal-ced'-o-ny [kal-ced'-o-ny]) A cryptocrystalline variety of quartz. It is commonly microscopically fibrous, may be translucent or semitransparent, and has a nearly waxlike luster. Chalcedony is the material of much chert, and often occurs as a deposit filling or lining cavities in rocks. See also: *agate*.

**chalcocite** (chal'-co-cite [kal'-co-site]) A black or dark lead-gray mineral:  $\text{Cu}_2\text{S}$ . It has a metallic luster, occurs in orthorhombic crystals or massive, and is an important ore of copper.

**chalcophile element** (chal'-o-phil [kal'-co-phil]) 1. An element that tends to concentrate in sulfide minerals and ores. 2. An element concentrated in the sulfide phase of meteorites and that is probably concentrated in the earth's mantle relative to its crust and core. Cf. *lithophile element*; *siderophile element*.

**chalcopyrite** (chal-co-py'-rite [kal-co-py'-rite]) A bright brass-yellow tetragonal mineral:  $\text{CuFeS}_2$ . It is generally found massive and constitutes the most important ore of copper. Syn. *copper pyrites*.

**chalk** A soft, earthy, fine-textured, usually white to light gray limestone of marine origin, consisting

almost wholly of calcite, formed mainly by shallow-water accumulation of calcareous tests of floating microorganisms (chiefly foraminifers) and of ground-up remains of calcareous algae (such as coccoliths and rhabdoliths). The rock may include the remains of bottom-dwelling forms (e.g. ammonites, echinoderms, and pelecypods), and nodules of chert. The best known and most widespread chalks are of Cretaceous age, such as those exposed in cliffs on both sides of the English Channel. Etymol: Old English *cealc*, from Latin *calx*, "lime".

**chalybeate** (cha-lyb'-e-ate [ka-lib'-e-ate]) An adj. applied to water strongly flavored with iron salts or to a spring yielding such water. Etymol: Greek, an ancient tribe of ironworkers in Asia Minor.

**chamber** (cham'-ber) 1 An enlargement of a cave passage, forming a room. 2 The fundamental unit of a foraminiferal test, consisting of a cavity and the wall surrounding it. 3 One of the regular, juxtaposed, hollow structures formed by the skeleton of certain sponges. 4. An internal division of a cephalopod shell.

**Champlainian** (Cham-plain'-i-an) Middle Ordovician of North America.

**chance packing** A random combination of systematically packed grains surrounded by, or alternating with, grains packed haphazardly. The average porosity of a chance-packed aggregate of uniform spheres is slightly less than

40%.

**Chandler wobble** (Chand'-ler) An aspect of the earth's rigid body motion that departs from simple or pure spin. It completes a cycle in about 428 days.

**channel** 1. The deepest portion of a stream, bay, or strait. 2. The part of a body of water deep enough to be used for navigation through an area otherwise too shallow. 3. A large strait, as the English Channel. 4. A linear current mark on a sedimentary surface, 0.5-2 m wide, 20-50 cm deep, and up to 30 m long. It is best developed in a *turbidite* sequence. 5. A groove in an invertebrate, such as the one that winds down the columella near its base in some gastropod shells and terminates in the siphonal notch or in the canal.

**channel capacity** The maximum flow which a given channel is capable of transmitting without overtopping its banks. See *bank-full stage*.

**channel-fill deposit** A deposit in a stream channel, esp. where the transporting capacity of the stream is insufficient to remove the material supplied to it.

**channel flow** Movement of surface runoff in long narrow depressions or troughs bounded by banks or valley walls that slope toward the channel.

**channelization** (chan'-nel-i-za'-tion) The straightening and deepening of a stream channel, to permit the water to move faster, to reduce flooding, or to drain

marshy acreage for farming  
**channel-mouth bar** A bar built where a stream enters a body of standing water, resulting from decrease in the stream's velocity.

**channel pattern** The configuration of a limited reach of a river channel as seen from an airplane. Recognized patterns include meandering, braided, sinuous, and relatively straight.

**channel sample** A composite rock sample, generally taken across the face of a formation or vein to give an average value.

**channel sand** A sand or sandstone deposited in a stream bed or other channel eroded into the underlying rocks. If exposed, such sands may contain gold or other valuable minerals, if buried, they may contain oil or gas. See also *shoe-string sand*.

**channel storage** The volume of water in a stream channel above a given measuring point at a given moment.

**channel wave** A wave that is propagated in a low-velocity layer within the earth, or in the ocean or atmosphere.

**chaos** (cha'-os [kay'-os]) A gigantic breccia associated with thrust faulting, consisting of large and small blocks of irregular shape and different ages, with little fine-grained material. Type example: the Amargosa chaos in Death Valley, Calif., in which blocks range up to 800 m in length. Cf. *mélange*.

**chaotic terrain** (cha-ot'-ic) Regions on Mars, first seen in 1969

on Mariner 6 images, that are topographically low and consist of irregular ridges, apparently formed at the expense of higher cratered terrain. It has been interpreted as a feature of *thermokarst topography*.

**char** The solid, carbonaceous residue that results from incomplete combustion of organic material. It can be burned for heat, or, if pure, processed for production of activated carbon for use as a filtering medium.

**characteristic fossil** (char'-ac-ter-is'-tic) A fossil species or genus that is characteristic of a stratigraphic unit (formation, zone series, etc.) or time unit. It is either confined to the unit or is particularly abundant in it. Inappropriate syn. *index fossil*. Syn. *diagnostic fossil*.

**charge** In seismic work, the explosive combination employed for a shot defined by the quantity and type of explosive used.

**charnockite** (char'-nock-ite) An orthopyroxene-bearing granite. Most classifications require that quartz constitute at least 20% of the felsic constituents and that the ratio of alkali feldspar to total feldspar fall between 40% and 90%. Charnockite is commonly found only in granulite-facies terranes, and high temperature and pressure are generally thought to be essential to its formation.

**chart 1.** A special-purpose map, esp. one designed for purposes of navigation, such as a *bathymetric chart*. **chart 2.** A base map conveying

information about something other than the purely geographic.

**chart datum** The plane or level to which soundings on a chart are referred, usually low water.

**chasm** 1. A deep breach, cleft, or opening in the earth's surface, such as a yawning fissure or narrow gorge; e.g. the Ausable Chasm near Koesville, N.Y. 2. A deep recess extending below the floor of a cave.—Syn: *abyss*.

**chatoyancy** (cha-toy'-an-cy) An optical phenomenon, possessed by certain minerals in reflected light, in which a movable wavy or silky sheen is concentrated in a narrow band of light that changes its position as the mineral is turned. It results from the reflection of light from minute, parallel fibers, cavities or tubes, or needle-like inclusions within the mineral. The effect may be seen on a cabochon-cut gemstone such as a chrysoberyl "cat's-eye".

**chatoyant** (cha-toy'-ant) adj. Said of a mineral or gemstone possessing *chatoyancy* or having a changeable luster or color marked by a narrow band of light.—n. A chatoyant gem.

**chattermark** (chat'-ter-mark) A small, curved scar made by vibratory chipping of a bedrock surface by rock fragments carried in the base of a glacier. Each mark is roughly transverse to the direction of ice movement, and usually convex toward the direction from which the ice moved. Cf: *crescentic fracture*.

**Chantuanan** (Chau-tau'-quan)

Uppermost Devonian of North America.

**chelation** (che-la'-tion [ke-la'-tion]) The taking-up or release of a metallic ion by an organic molecule; base exchange by means of an organic compound. It may be important in weathering.

**chemical activity** (chem'-i-cal) *activity*.

**chemical limestone** A rock composed predominantly of calcite, formed by direct chemical precipitation or by consolidation of calcareous ooze.

**chemical oxygen demand** The amount of oxygen required for the oxidation of the organic matter in a water sample or a water body. Abbrev: COD. Cf: *biochemical oxygen demand*. Syn: *oxygen demand*.

**chemical potential** An intensive quantity of a component in a system, equal to the change of the Gibbs free energy of the system, with the change in the number of moles *mi*, the temperature, pressure, and number of moles of the other components being kept constant. It is defined at each point of the system. See also: *Gibbs free energy*; *intensive variable*.

**chemical remanent magnetization** A stable remanent magnetization caused by the slow growth of magnetically ordered mineral grains in the presence of a magnetic field, e.g. during such processes as oxidation, reduction, or exsolution.

**chemical weathering** The process of weathering by which chemical



reactions (hydrolysis, hydration, oxidation, carbonation, ion exchange, and solution) transform rocks and minerals into new chemical combinations that are stable under conditions prevailing at or near the earth's surface; e.g. the alteration of orthoclase to kaolinite. Cf: *mechanical weathering*. Syn: *decomposition*; *decay*.

**chenier** (che-nier') A long narrow wooded beach ridge or sandy hummock, 3 to 6 m high, forming roughly parallel to a prograding shoreline seaward of marsh and mud-flat deposits (as along the coast of southern Louisiana), enclosed on the seaward side by fine-grained sediments, and resting on peat or clay. It is well drained and fertile, often supporting large evergreen oaks or pines on higher areas; its width ranges from 45 to 450 m and its length may be several tens of kilometers. Etymol. French *chêne*, "oak". Locally pronounced "ahin'-a-ree"

**chert** A hard, dense microcrystalline or cryptocrystalline sedimentary rock, consisting chiefly of interlocking crystals of quartz less than about 30  $\mu$ m in diameter; it may contain amorphous silica (opal). It has conchoidal fracture, and may be white or variously colored. Chert occurs principally as nodular or concretionary segregations, or nodules, in limestone and dolomite, and less commonly as layered deposits, or bedded chert; it may be an organic or inorganic precipitate or a replacement product. The term *flint* is

essentially synonymous.

**chertification** (chert'-i-fi-ca'-tion) Essentially silicification, especially by fine-grained quartz or chalcedony.

**Chesterian** (Ches-ter'-i-an) Uppermost Mississippian of North America.

**chevron fold** (chev'-ron) A *kink fold*, the limbs of which are of equal length. Cf: *zigzag fold*.

**chiastolite** (chi-as'-to-lite) A variety of andalusite, in which carbonaceous impurities are arranged in a regular manner along the longer axis of the crystal, in some varieties like the letter X (Greek "chi"), whence the name. It is used for amulets, charms, and other costume jewelry

**chickenwire anhydrite** (chick'-en-wire) Irregularly polygonal nodules of anhydrite (or pseudomorphous gypsum), 1 to 5 cm in diameter, separated by thin darker stringers of other minerals, generally carbonates or clays. It may be diagnostic of sabkha deposition, or the result of porphyroblastic recrystallization.

**Chile saltpeter** Naturally occurring sodium nitrate,  $\text{NaNO}_3$ , occurring in caliche in northern Chile. Cf: *saltpeter*. Syn: *soda niter*.

**chimney** 1 A cylindrical, more or less vertical, core body. 2. A chimney-shaped column of rock rising above its surroundings or isolated on the face of a steep slope; a small, weathered outlier shaped like a sharp pinnacle; a small *stack*. Syn: *chimney rock*. 3. A

vertical passage or opening in a cave. 4. A conduit through which magma reaches the earth's surface.

**china clay** A commercial term for *kaolin* which, after processing, is suitable for use in the manufacture of chinaware.

**chip sample** A series of small pieces of ore or rock taken at regular intervals across a vein or exposure.

**chi-square test** A statistical test that employs the sum of values given by the quotients of the squared difference between observed and expected (theoretical) frequencies divided by the expected frequency. It enables assessment of association or commonality in a population, and is used to determine equivalency of observed sample and expected population.

**chitin** (chi'-tin [ky'-tin]) A resistant organic compound with the same basic carbohydrate structure as cellulose, but containing nitrogen. It is a common constituent of the arthropod exoskeleton.

**chiton** (chi'-ton [ky'-ton]) An invertebrate marine mollusk, class Amphineura, the shell of which consists of eight overlapping calcareous valves or plates. It is popularly called the "coat of mail" shell.

**chlorapatite** (chlor-ap'-a-tite) 1. An apatite mineral in which chlorine predominates over fluorine and hydroxyl. 2. A rare mineral of the apatite group:  $\text{Ca}_5(\text{PO}_4)_3\text{Cl}$ .

**chloride** (chlo'-ride) A compound

of chlorine and a positive radical of one or more elements.

**chlorinity** (chlo-rin'-i-ty) The chloride content of seawater, measured by mass, or grams per kilogram of seawater, and including the chloride equivalent of all the halides. Syn: *chlorine equivalent*.

**chlorite** (chlo'-rite) A group of platy, monoclinic, usually greenish minerals of the general formula:  $(\text{Mg}, \text{Fe}^{+2}, \text{Fe}^{+3})_6\text{AlSi}_3\text{O}_{10}(\text{OH})_2$ . Chlorites are associated with and resemble the micas; they may also be considered as clay minerals. They are widely distributed, esp. in low-grade metamorphic rocks, or as alteration products of ferromagnesian minerals.

**chloritization** (chlo'-rit-i-za'-tion)

The replacement by, conversion into, or introduction of chlorite.

**chloritoid** (chlo'-ri-toid) A mica-ceous mineral:  $\text{Fe}_2\text{Al}_4\text{Si}_2\text{O}_{10}(\text{OH})_4$ . It occurs in green to gray or grayish-black masses of brittle folia in metamorphosed argillaceous sedimentary rocks, and is related to the brittle micas. Magnesium may be present.

**Chondrichthyes** (Chon-drich'-thyes [Con-drik'-the-eze]) A class of vertebrates including fish with skeletons of cartilage rather than bone; esp. the sharks.

**chondrite** (chon'-drite [con'-drite])

1. A stony meteorite containing chondrules embedded in a fine-grained matrix of pyroxene, olivine, and nickel-iron with or without glass. They constitute more than 80% of meteorite falls. 2. A

common *trace fossil* consisting of plantlike tunnel structures that radiate from a central vertical tube. It was probably the dwelling or feeding burrow of a marine worm. See also: *fucoïd*.

**chondrule** (chon'-drule [con'-drule]) A spheroidal granule, usually about one millimeter in diameter, consisting chiefly of olivine and/or enstatite or bronzite, and occurring embedded in the fragmental bases of many stony meteorites (chondrites).

**chonolith** (chon'-o-lith [con'-o-lith]) An igneous intrusion whose form is so irregular that it cannot be classified as a laccolith, dike, sill, or other recognized body.

**Chordata** (Chor-da'-ta) A phylum of animals including those having a notochord, which in most forms is represented by a bony spinal column. The phylum includes the *Vertebrata*, and may or may not be considered to include the *Protochordata*.

**C horizon** The layer of weathered bedrock at the base of a soil. It has undergone little alteration by organisms and is presumed to be similar in composition to the material from which at least a portion of the overlying soil developed.

**chromate** (chro'-mate) A mineral containing the chromate ion  $\text{CrO}_4^{-2}$ . An example is chromatite,  $\text{CaCrO}_4$ .

**chromatography** (chro-ma-tog'-ra-phy) A general name for several processes of separating components of a sample by moving the

sample in a mixture or solution over or through a medium using adsorption, partition, ion exchange, or other property in such a way that the different components have different mobilities and thus become separated.

**chromite** (chro'-mite) A brownish-black to iron-black mineral of the spinel group:  $(\text{Fe}, \text{Mg}) (\text{Cr}, \text{Al})_2 \text{O}_4$ . It occurs in octahedral crystals as an accessory mineral in basic and ultrabasic igneous rocks, it also occurs massive and in detrital deposits. Chromite is the most important ore of chromium.

**chron** A general term for an indefinite division of geologic time, e.g. the time span of a *chronozone*.

**chronofauna** (chron'-o-fau-na) A geographically restricted natural assemblage of interacting animal populations that maintained its basic structure over a geologically significant period of time.

**chronohorizon** (chron'-o-ho-ri'-zon) A stratigraphic surface that is everywhere of the same age. Although theoretically without thickness, it is commonly a thin and distinctive interval that constitutes an excellent time-reference or time-correlation zone. Examples: many biohorizons, bentonite bed horizons of magnetic reversal, and coal beds. Cf: *lithohorizon*.

**chronolithologic unit** (chron'-o-lith'-o-log'-ic) *chronostratigraphic unit*.

**chronostratigraphic unit** (chron'-o-strat'-i-graph'-ic) A body of

rock strata that was formed during a specific interval of geologic time. It represents all the rocks formed during a certain time span of earth history, and only those rocks. Chronostratigraphic units in order of decreasing rank: *era*, *them*, *system*, *series*, *stage*, *chronozone*. Syn: *chronolithologic unit*; *time-stratigraphic unit*; *time-rock unit*; *chronolith*. See also: *chronozone*.

**chronostratigraphy** (chron'-o-stratig'-ra-phy) The branch of stratigraphy that deals with the age of strata and their time relations. Syn: *time-stratigraphy*.

**chronotaxy** (chron'-o-tax-y) Similarity of time sequence; specif. correlation of fossil or stratigraphic sequences on identity in time, or the determination of age equivalence. The term was originally proposed as *chronotaxis*. Cf: *homotaxy*.

**chronozone** (chron'-o-zone) 1 A general term for all rocks formed anywhere during the time range of some geologic feature or specified interval of rock strata. 2. A formal term for the lowest ranking division in the hierarchy of *chronostratigraphic units*, of lower rank than a stage. Syn: *chronostratigraphic zone*.

**chrysoberyl** (chrys-o-ber'-yl) A mineral:  $\text{BeAl}_2\text{O}_4$ . It is usually yellow, pale green, or brown, and is used as a gem. Principal varieties are cat's-eye and alexandrite.

**chrysocolla** (chrys-o-col'-la) A mineral,  $(\text{Cu}, \text{Al})_2\text{H}_2\text{Si}_2\text{O}_5(\text{OH})_4 \cdot n\text{H}_2\text{O}$ . It usually occurs as green

to blue-green incrustations and thin seams in the oxidized zone of copper-sulfide deposits.

**chrysolite** (chrys'-o-lite) A pale yellow to yellowish-green gem variety of *olivine*. Not to be confused with *chrysotile*.

**chrysoprase** (chrys'-o-prase) An apple-green chalcedony, used as a gem.

**chrysotile** (chrys-o-tile') A white, gray, or greenish mineral of the serpentine group:  $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$ . It is a fibrous, silky variety of serpentine, and constitutes the most important type of *asbestos*. Not to be confused with *chrysolite*. Syn: *serpentine asbestos*.

**chute** 1. A waterfall or rapids. 2. A narrow channel through which water flows rapidly; specif. a *chute cutoff*. 3. An inclined channel or passage in a cave. 4. A var of *shoot*, as in *ore shoot*.

**chute cutoff** A narrow "short cut" across a meander bend, formed at time of flood when the main flow of a stream is diverted to the inside of the bend, along or through a trough between adjacent parts of a point bar. Cf: *neck cutoff*. Syn: *chute*.

**CI contour interval.**

**ciénaga** (ci-e'-na-ga [see-en'-a-ga]) A marshy area where the ground is wet due to the presence of seepage or springs, often with standing water and abundant vegetation. The term is commonly applied in arid regions such as the southwestern U.S. Etymol: Spanish *ciénaga*, "marsh, bog, miry place". Also spelled: *ciénega*.

**Cincinnati** (Cin-cin-nat'-i-an) Upper Ordovician of North America.

**cinder cone** A conical hill formed by the accumulation of cinders and other pyroclasts around a volcanic vent.

**cinders** (cin'-ders) Glassy vesicular volcanic fragments, ranging in size from 4 to 32 mm, that fall to the ground in a solid condition. Cf: *lapilli*.

**cinnabar** (cin'-na-bar) A rhombohedral mineral, HgS, commonly in brilliant red acicular crystals. It is the principal ore of mercury.

**CIPW classification** A system for classifying and naming igneous rocks. The initials represent the names of the men who devised the system in 1902, Cross, Iddings, Pirsson, and Washington. Syn: *quantitative system, norm system*.

**circular section** (cir'-cu-lar) 1. In a uniaxial crystal, an equatorial section perpendicular to the optic axis; in a biaxial crystal, one of two sections intersecting the beta axis of the biaxial indicatrix. 2. One of the two circular cross sections through the strain ellipsoid.

**circulation** (cir-cu-la'-tion) 1. In *rotary drilling*, the process of pumping mud-laden or other fluid down the drill pipe, through the bit, and back to the surface through the annulus between drill-hole wall and drill pipe. See also: *lost circulation*. 2. The complete mixing of lake waters, often at the temperature of maximum density. 3. The flow of water in a large area of the ocean, usually in

a closed pattern or gyre, due to wind or to varying densities of water resulting from differences in salinity and temperature.

**circum-Pacific belt** (cir'-cum-Pa-cif'-ic) The belt of major tectonic activity that borders the Pacific Ocean along the continental margins of Asia and the Americas, and meets the *Eurasian-Melanesian belt* in the Celebes.

**cirque** 1. A deep steep-walled recess or hollow, horseshoe-shaped or semicircular in plan view, situated high on the side of a mountain and produced by the erosive activity of a mountain glacier. It often contains a small round lake. Etymol: French, from Latin *circus*, "ring". Syn: *corrie*. 2. A term sometimes used for an armchair-shaped or amphitheaterlike hollow of nonglacial origin.

**cirque glacier** A small glacier occupying a cirque or resting against the headwall of a cirque.

**cirque lake** A small, deep, commonly circular glacial lake occupying a cirque; it is fed by runoff from the surrounding slopes and dammed by a lip of bedrock or by a small moraine. Syn: *tarn*.

**citrine** (sit'-rine) A yellow variety of crystalline quartz, closely resembling topaz in color.

**cladogenesis** (clad-o-gen'-e-sis) 1. Phyletic splitting or branching; speciation. 2. Progressive evolutionary specialization.

**clad mining claim**

**clam** A popular term for a bivalve mollusk (pelecypod), commonly applied to an edible one that lives

partially or completely buried in sand or mud.

**clan** 1. A group of igneous rocks that are closely related in chemical composition. 2. A category in the hierarchy of classification used by some zoologists; it ranks below subfamily and above genus. 3. A small ecologic community that has only one dominant species.

**clarain** (clar'-ain) An ingredient of banded coal with semibright, silky luster and sheetlike or irregular fracture. It is distinguished from *vitrain* by containing fine intercalations of a duller lithotype, *durain*. Cf: *fusain*.

**clarke** The average abundance of an element in the crust of the earth. It is named in honor of F.W. Clarke. Cf: *clarke of concentration*. Syn: *crustal abundance*.

**clarke of concentration** The concentration of an element in a mineral or rock relative to its crustal abundance. The term is applied to specific as well as average occurrences. Cf: *clarke*.

**class** 1. *crystal class*. 2. A category in the hierarchy of classification of animals and plants, intermediate between phylum and order. 3. In the CIPW classification of igneous rocks, a subdivision based on the relative proportions of silic and femic standard minerals.

**classification** (clas'-si-fi-ca'-tion) The formal arrangement of organisms in hierarchy of taxonomic categories. Cf: *systematics*; *taxonomy*.

**clast** 1. An individual constituent grain, or fragment of a detrital sediment or sedimentary rock, produced by the physical disintegration of a larger rock mass. 2. A constituent of a *bioclastic rock*. 3. A *pyroclast*.

**clastation** (clas-ta'-tion) 1. The breaking-up of rock masses in situ by physical or chemical means; *weathering*. 2. The disrupting of rocks to form clastic sediments.

**clastic** (clas'-tic) adj. 1. Pertaining to a rock or sediment composed principally of fragments derived from pre-existing rocks or minerals and transported some distance from their places of origin; also said of the texture of such a rock. 2. *pyroclastic*. 3. Said of a *bioclastic rock*. 4. Pertaining to the fragments (clasts) composing a clastic rock.—n. A clastic rock. Term is usually used in the plural; e.g. the commonest "clastics" are sandstone and shale.

**clastic dike** A tabular body cutting across the bedding of a sedimentary formation and consisting of a variety of clastic materials derived from underlying or overlying beds; esp. a *sandstone dike* or a *pebble dike*.

**clastic pipe** A cylindrical body of clastic material, having an irregular columnar or pillarlike shape, standing approximately vertical through enclosing formations (usually limestone), and measuring a few centimeters to 50 m in diameter and a meter to 60 m in height; esp. a *sandstone pipe*. Syn: *cylindrical structure*.

**clastic ratio** The ratio of the thickness or percentage of clastic material (conglomerate, sandstone, shale) to that of nonclastic material (limestone, dolomite, evaporites) in a stratigraphic section. Cf: *sand-shale ratio*. Syn: *detrital ratio*.

**clastic rock** 1. A sedimentary rock composed principally of fragments derived from pre-existing rocks and transported mechanically to their places of deposition; e.g. a sandstone, conglomerate, or shale, or a limestone consisting of particles derived from a pre-existing limestone. See also: *epiclastic rock*. Syn: *fragmental rock*. 2. *pyroclastic rock*. 3. *bioclastic rock*. 4. A *cataclastic rock*.

**clastic wedge** The sediments of an exogeosyncline, derived from the tectonic land masses of the adjoining orthogeosynclinal belt. Cf: *geosynclinal prism*.

**clay** 1. A detrital mineral particle of any composition having a diameter less than  $1/256$  mm (4 microns). This is approximately the upper limit of size of particle that can show colloidal properties. 2. An earthy, extremely fine-grained sediment or soft rock composed primarily of clay-size or colloidal particles, having high plasticity and a considerable content of *clay minerals*. Clays may be classified by use, origin, mineral composition, or color; they have many uses. 3. A term commonly applied to any wet, adhesive earth material, such as mud. 4. *clay mineral*.

**C layer** The seismic region of the earth between 410 km and 1000 km, equivalent to the *transition zone* of the upper mantle. It is a part of a classification of the earth's interior made up of layers A to G.

**clay gall** A curled "clay-shaving" resulting from the drying and cracking of mud, which is later embedded in a sand stratum. Named because it resembles the gall of the mud wasp.

**clay gouge** 1. A clayey deposit in a fault zone; *fault gouge*. 2. A thin seam of clay separating masses of ore, or separating ore from country rock. See also: *gouge*.

**clay ironstone** A hard gray or brown fine-grained sedimentary rock, consisting of clay (up to 30%) and iron carbonate (siderite), occurring in nodules, concretions, or irregular thin beds; a clayey iron carbonate or an impure siderite ore. Clay ironstone is usually associated with carbonaceous strata, esp. overlying coal seams in the coal measures of the U.S. and Great Britain. See also: *ironstone*.

**clay mineral** One of a complex and loosely defined group of hydrous silicate minerals, essentially of aluminum. They have a monoclinic layered crystal lattice. The extremely small particle size imparts ability to adsorb water and ions on the particle surfaces. Most clay minerals belong to the kaolin, smectite (montmorillonite), and illite groups; the micas and chlorite are close relatives. Cf:

**clay.**

**claypan** A soil term for a dense, heavy, relatively impervious subsoil layer that owes its character to a high content of clay concentrated by downward-percolating waters. Cf: *hardpan*.

**clay plug** A mass of silt, clay, and organic muck, deposited in and eventually filling an oxbow lake.

**clay shale** 1. A shale composed wholly or chiefly of argillaceous material, which again becomes clay on weathering. 2. A consolidated sediment consisting of no more than 10% sand and having a silt/clay ratio of less than 1:2; a fissile claystone.

**clay slate** 1. A low-grade, essentially unreconstituted slate, as distinguished from the more micaceous varieties; e.g. an *argillite*, less than 50% reconstituted, with slaty cleavage or incipient foliation. 2. A slate derived from shale, rather than from volcanic ash, with cleavage developed by shearing, as distinguished from "mica slate".

**claystone** 1. An indurated clay having the texture and composition of shale but lacking its fine lamination or fissility. 2. A concretionary body of clay in alluvium or of calcareous material in clay.

**clay vein** A body of clay, usually roughly tabular in form, that fills a crevice in a coal seam. Cf: *clastic dike*.

**cleavage** (cleav'-age) 1. The breaking of a mineral along its crystallographic planes, thus reflecting

crystal structure, e.g. *cubic cleavage*. Cf: *fracture*. 2. The property or tendency of a rock to split along parallel, closely spaced planar surfaces. It is independent of bedding and is produced by deformation or metamorphism. Cf: *schistosity*.

**cleavelandite** (cleave'-land-ite) A white, lamellar variety of albite common in pegmatites.

**Clerici solution** (Cle-n'-ci) A solution of thallium malonate and thallium formate in water that is used as a *heavy liquid*; its specific gravity is 4.15. Cf: *bromoform*; *methylene iodide*.

**cliff** A high, steep face of rock; a precipice. Cf: *sea cliff*.

**climate** (cli'-mate) The characteristic weather of a region, particularly as regards temperature and precipitation, averaged over some significant interval of time. Climates are classified on the basis of such factors as temperature, rainfall, vegetation, or position relative to land and sea. See also: *climatic province*.

**climate-stratigraphic unit** *geologic-climate unit*.

**climatic optimum** (cli-mat'-ic) An interval of relatively high temperature since the retreat of the last Pleistocene glacier, a climatic warming between 5000 and 7000 years ago.

**climatic province** A region characterized by a particular *climate*.

**climatic zone** A latitudinally oriented region characterized by a relatively homogeneous climate, e.g. tropical zone or temperate



zone.

**climax** (cli'-max) In ecology, the final stable or equilibrium stage of development that a sere, community, species, flora, or fauna attains in a given environment. Cf: *pioneer*.

**climbing bog** An elevated boggy area on the margin of a swamp, usually in a region characterized by a short summer and considerable rainfall, caused by the upward growth of sphagnum from the original level of the swamp to higher ground.

**climbing dune** A dune formed by the piling-up of sand by wind against a cliff or mountain slope.

**clinker** 1. Coal that has been altered by igneous intrusion. Cf: *natural coke*. 2. A slaggy or vitreous mass of coal ash. 3. A rough, jagged fragment of lava.

**clino** (cli'-no) adj. A term applied to the environment of sedimentation that lies on the sloping part of the floor of the sea, extending from wave base down to the more or less level deeper parts. It may be used alone or as a combining form. See also: *clinoform*; *clinotherm*. Cf: *unda*; *fonda*.

**clinaxis** (cli'-no-ax'-is) The inclined lateral axis in the monoclinic system, designated *a*.

**clinodome** (cli'-no-dome) A crystal form in the monoclinic system whose faces are parallel to the inclined *a*-axis and intersect the other two.

**clinoclasite** (cli'-no-en'-sta-tite) A mineral of the clinopyroxene group: (Mg,Fe)SiO<sub>3</sub>; specif. the

monoclinic magnesium silicate MgSiO<sub>3</sub>.

**clinoform** (cli'-no-form) The subaqueous land form analogous to the continental slope of the oceans or to the foreset beds of a delta. It is the site of the *clino* environment of deposition. Cf: *undaform*; *fondoform*.

**clinometer** (cli-nom'-e-ter) A simple apparatus for measuring vertical angles, particularly dip, by means of a pendulum or spirit level and circular scale.

**clinopinacoid** (cli'-no-pin'-a-coid) In a monoclinic crystal, the pair of faces that are parallel to the *a* and *b* crystallographic axes.

**clinopyroxene** (cli'-no-py'-rox-ene) Any of a group of pyroxenes crystallizing in the monoclinic system and sometimes containing considerable calcium with or without aluminum and the alkalis.

**clinotherm** (cli'-no-them) Rock units formed in the *clino* environment of deposition. Cf: *unda-them*; *fondothem*.

**Clinton ore** (Clim'-ton) A red, fossiliferous sedimentary iron ore, e.g. the Clinton Formation (Middle Silurian) or correlative rocks of the east-central U.S., containing lenticular or oolitic grains of hematite. Cf: *fossil ore*; *flaxseed ore*.

**clod** A term applied by miners to loosely consolidated shale or earthy clay commonly found in close conjunction with a coal bed.

**closed basin** A district draining to some depression or lake within its

area, from which water escapes only by evaporation.

**closed fold** *isoclinal fold*.

**closed form** A crystal form whose faces enclose space, e.g. a dipyrmaid. Cf: *open form*.

**closed structure** An anticline, syncline, or other structure that is represented on a map by one or more closed structure-contour lines.

**closed system** A system in which, during the process under consideration, no transfer of matter either into or out of the system takes place.

**close-grained** Said of a rock, and of its texture, characterized by fine, tightly packed particles.

**close packing** The manner of arrangement of uniform solid spheres packed as closely as possible so that the porosity is at a minimum. See also: *rhombohedral packing*. Ant: *open packing*.

**closure** (clo'-sure) 1. In a subsurface anticline or other structural trap, the vertical distance between the structure's highest point and its lowest closed *structure contour*. It is used in the estimation of oil or gas reserves. 2. In surveying, a cumulative measure of errors; the amount by which a series of survey measurements fails to yield a theoretical or previously determined value.

**coal** A readily combustible rock containing more than 50% by weight and more than 70% by volume of carbonaceous material including inherent moisture, formed from compaction and in-

duration of variously altered plant remains similar to those in peat. Differences in the kinds of plant materials (type), in degree of metamorphism (rank), and in the range of impurity (grade) are used in classification. Syn: *black diamond*.

**coal ball** A concretion of mineralized plant debris, occurring in a coal seam or in adjacent rocks.

**coal basin** A coal field with basinal structure, e.g. the Carboniferous Coal Measures of England.

**coalescing pediment** (co-a-les'-cing) The union of individual pediments which results in a continuous pediment surrounding a mountain range.

**coal field** A region in which deposits of coal occur. See also: *coal basin*.

**coal gas** The fuel gas produced from a high-volatile bituminous coal. Its average composition, by volume, is 50% hydrogen, 30% methane, 8% carbon monoxide, 4% other hydrocarbons, and 8% carbon dioxide, nitrogen, and oxygen.

**coalification** (coal'-i-fi-ca'-tion) The biochemical processes of diagenesis and the geochemical processes of metamorphism in the formation of coal. See also: *carbonization*; *incorporation*. Syn: *carbonification*.

**Coal Measures** A stratigraphic term used in Europe (esp. in Great Britain) for Upper Carboniferous. It is broadly synchronous with the Pennsylvanian of North America. See also: *coal*

*measures.*

**coal measures** A succession of sedimentary rocks ("measures") ranging in thickness from a meter or so to a few thousand meters, and consisting mainly of clastic rocks with interstratified beds of coal. See also: *Coal Measures*.

**coal plant** A fossil plant found in association with, or contributing by its substance to the formation of, beds of coal, esp. in the coal measures

**coal seam** A stratum or bed of coal

**coal type** A classification of coal distinguished on the basis of the constituent plant materials. Cf: *grade; rank*.

**coarse aggregate** The portion of an *aggregate* consisting of particles with diameters greater than approximately 1/4 inch or 4.76 mm. Cf: *fine aggregate*.

**coarse-grained** 1. Said of a crystalline rock, and of its texture, in which the individual minerals are relatively large, e.g. an igneous rock whose particles have an average diameter greater than 5 mm (0.2 in.). Syn: *phaneritic*. 2. Said of a sediment or sedimentary rock, and of its texture, in which the individual constituents are easily seen with the unaided eye, i.e. have an average diameter greater than 2 mm (0.08 in.). The term is used in a relative sense, and various size limits have been suggested and used. Cf: *fine-grained; medium-grained*.

**coarse sand** Sand with particle diameters between 0.5 and 1 mm.

**coarse topography** An incompletely dissected land surface, or one in which the erosional features are on a large scale.

**coast** 1. A strip of land of indefinite width (up to many kilometers) that extends from the seashore inland to the first major change in terrain features. 2. The part of a country regarded as near the coast, often including the whole of the *coastal plain*.

**coastal plain** (coast'-al) A low, broad plain that has its margin on an oceanic shore and its strata either horizontal or very gently sloping toward the water, and that generally represents a strip of recently prograded or emerged sea floor.

**coastline** 1. The boundary between land and water, esp. the water of a sea or ocean. 2. A general term to describe the appearance or configuration of the land along a coast, esp. as viewed from the sea. 3. A broad zone of land and water extending indefinitely both landward and seaward from a shoreline.—Cf: *shoreline*.

**Coast Range orogeny** Major deformation, metamorphism, and plutonism during Jurassic and Early Cretaceous time in the Coast Mountains of the Cordillera of British Columbia. It is broadly equivalent to the *Ne-vadan orogeny* of the U.S.

**coast shelf** Submerged coastal plain.

**cobaltite** (co'-bal-tite) A gray to silver-white isometric mineral, CoAsS, the principal ore of co-

balt.

**cobbling** The separation, generally with a hand-held hammer, of worthless minerals from desired minerals in a mining operation, e.g. quartz from feldspar.

**cobble** (cob'-ble) A rock fragment between 64 and 256 mm in diameter, thus larger than a pebble and smaller than a boulder, rounded or otherwise abraded in the course of aqueous, eolian or glacial transport. Cf: *cobblestone*.

**cobblestone** A rounded stone suitable for use in paving or other construction. Cf: *cobble*.

**coccolith** (coc'-co-lith) A general term applied to various microscopic calcareous plates having many different shapes and averaging about 3 microns in diameter, constructed of calcite or aragonite crystals, and constituting the outer skeletal remains of a *coccolithophore*. Coccoliths are found in chalk and in deep-sea oozes of the temperate and tropical oceans.

**coccolithophore** (coc'-co-lith'-o-phore) A minute marine planktonic flagellate organism that produces *coccoliths*.

**cockade ore** (cock-ade') An open-space vein filling in which ore and gangue minerals are deposited in successive comblike crusts around rock fragments, e.g. in vein breccia.

**COD** *chemical oxygen demand*.

**coelacanth** (coe'-la-canth [see'-la-canth]) A member of a suborder of *crossopterygian* fish that entered marine waters during the Mesozoic; it includes the sole liv-

ing representative, the genus *Latimeria*. Range, Upper Devonian to Recent.

**coelenterate** (coe-len'-ter-ate [see-len'-ter-ate]) Any multicelled invertebrate animal, solitary or colonial, belonging to the phylum Coelenterata, characterized by a body wall of two layers of cells connected by a structureless mesogloea, by a simple body cavity with a single opening for ingestion and egestion, and by radial or biradial symmetry. Range, Precambrian to present.

**coelom** (coe'-lom [see'-lom]) The general body cavity occurring in multicelled animals other than the sponges and coelenterates. Where well developed, it forms a space between the alimentary viscera and the body walls. Adj: *coelomic*. Also spelled: *coelome*.

**coesite** (coes'-ite [ko'-site]) A monoclinic mineral, SiO<sub>2</sub>. It is a very dense polymorphic form of quartz that is stable at room temperatures only at pressures above 20,000 bars. Found in impact craters and associated structures.

**cognate inclusion** (cog'-nate) *autolith*.

**cohesion** (co-he'-sion) *Shear strength* of a rock not related to interparticle friction. Cf: *adhesion*.

**coke** A combustible material produced by heating bituminous coal and driving off its volatile matter, i.e. by carbonization. It consists of mineral matter and fixed carbon fused together; it is gray, hard, and porous, and as a fuel is

nearly smokeless and of high calorific value. Cf: *clinker*; *natural coke*; *charcoal*.

**coking coal** A coal suitable for the production of coke.

**col 1.** A high, sharp-edged pass in a mountain range, esp. one formed by the headward erosion of two cirques, as in the French Alps. **2.** A marked, saddle-like depression in the crest of a mountain ridge; the lowest point on a ridge. Syn: *saddle*. —Etymol: French, from Latin *collum*, "neck". Cf: *gap*; *notch*.

**cold glacier** *polar glacier*.

**colemanite** (cole'-man-ite) A colorless or white monoclinic mineral:  $\text{Ca}_2\text{B}_6\text{O}_{11} \cdot 5\text{H}_2\text{O}$ . It is an important source of boron, occurring in massive crystals or as nodules in clay.

**coleoid** (co'-le-oid) Any member of the subclass Coleoidea (Dibranchiata) of the cephalopods, having a muscular mantle, internal shell, and two gills, among other distinguishing features. Syn: *dibranchiate*. Range, Lower Carboniferous to the present.

**collapse breccia** (col-lapse') A mass of angular fragments formed by the collapse of rock overlying an opening, as by foundering of the roof of a cave or of the country rock above an intrusion; e.g. a *solution breccia*. Syn: *founder breccia*.

**collapse caldera** A caldera produced by collapse of the roof of a magma chamber owing to removal of magma by eruption or by subterranean withdrawal. Most

calderas are of this type. Cf: *explosion caldera*.

**collapse structure** Any rock structure resulting from removal of support and consequent collapse, e.g. gravitational sliding on fold limbs, salt solution causing collapse of overlying rocks in salt basins, sink-hole collapse, or collapse into mine workings.

**collar** (col'-lar) **1.** The mouth or upper end of a mine shaft. **2.** In deep drilling, a length of extra-heavy drill pipe above the rotary bit or core barrel, to concentrate weight and give rigidity so that the bit will cut properly.

**collector well** (col-lec'-tor) A large-diameter well consisting of a concrete cylinder, sealed at the bottom, with perforated pipes extending radially into an aquifer. Collector wells are most often constructed in alluvial formations adjoining rivers; water moves downward through the stream bed to the pipes. Syn: *Ranney collector*.

**collimate** (col'-li-mate) **1.** To bring into line, as the axes of two lenses or of two telescopes. Also, to make parallel, as refracted or reflected rays. **2.** To correct the line of sight of a telescope, as by use of a collimator.

**collimation axis** (col-li-ma'-tion) The straight line passing through the rear nodal point of the objective lens, perpendicular to the horizontal axis of the telescope in a transit or theodolite, and to the vertical axis in a leveling instrument.

**collimation error** The angle between the line of sight of an optical instrument and its *collimation axis*

**collimation line** The line of sight of the telescope of a surveying instrument, through the rear nodal point of the objective lens and the intersection of the crosshairs when these points are in perfect alignment

**collimation plane** The plane described by the collimation axis during the revolution of a transit

**collimator** (col'-li-ma-tor) An optical device for producing a beam of parallel rays of light or for artificially creating an infinitely distant target that can be viewed without parallax. It is used in testing and adjusting certain optical surveying instruments

**colloform** (col' lo-form) Said of the rounded, finely banded kidney-like mineral texture formed by ultra-fine-grained rhythmic precipitates once thought to denote deposition of colloids. Cf *bryoidol*, *reniform*

**colloid** (col'-loid) 1 A particle-size range of less than 0.00024 mm, i.e. smaller than clay size. 2 Any extremely fine-grained material in suspension, or that can be easily suspended, commonly having peculiar properties because of its very high surface area. A common colloid in nature is clay, which has such properties as plasticity, thixotropy, and swelling

**colloidal dispersion** (col'-loid'-al) 1 A suspension of particles of colloidal size in a medium, usually

liquid, a *sol*. 2 An *aerosol*

**collophanite** (col'-lo-phane) Any of the massive cryptocrystalline varieties of apatite, often opaline, dull, or snow-white in appearance, that constitute the bulk of phosphate rock and fossil bone and that are used as a source of phosphate for fertilizers, esp *carbonate-apatite* or a hydroxylapatite containing carbonate. It is probably not a true mineral. Syn *collophanite*

**collophanite** (col'-loph-a-nite) *collophanite*

**colluvial** (col'-lu'-vi-al) Pertaining to colluvium, e.g. 'colluvial deposits'

**colluvium** (col'-lu'-vi-um) A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity. Talus and cliff debris are included in such deposits. Adj *colluvial*. Cf *slope wash*

**colonial coral** (co-lo'-ni-al) A coral in which many individuals are attached as a unit and cannot exist as separate animals. Cf *solitary coral*

**colonization** (col'-o-ni-za'-tion) A natural phenomenon wherein a species invades an area previously unoccupied by it and becomes established there

**colony** (col'-o-ni) 1 A group of similar organisms living together in close association, e.g. graptolites or anthozoan corals. 2 A group of living or fossil organisms found in an atypical area or rock unit, or that migrate into and

become established in a barren area

**color index** In petrology, esp in the classification of igneous rocks, a number that represents the percent, by volume, of dark-colored (i.e. mafic) minerals in a rock. According to this index, rocks may be divided into 'leucocratic' (color index, 0-30), "mesocratic" (color index 30-60), and "melanocratic" (color index, 60-100) Syn *color ratio*  
*color ratio* *color index*

**columbite** (co-lum'-bite) A black mineral, the Nb-rich end member of the columbite-tantalite series  $(\text{Fe,Mn})^{3+}(\text{Nb,Ta})_2\text{O}_6$ . It occurs in granites and pegmatites and is an ore mineral of niobium and tantalum

**columnar jointing** (col-um'-nar) Parallel prismatic columns polygonal in cross section in basaltic flows and sometimes in other extrusive and intrusive rocks. It is formed as the result of contraction during cooling. Syn *columnar structure* *prismatic structure*

**columnar section** A graphic representation of the sequence of rock units in an area or at a specific locality. Thicknesses are drawn to scale, and lithology is indicated by standard or conventional symbols, usually supplemented by brief descriptive notes. See also *geologic column*

**columnar structure** 1 *columnar jointing* 2 A columnar, subparallel arrangement shown by aggregates of slender, elongate mineral crystals 3 A primary sedi-

mentary structure in some calcareous shales or argillaceous limestones, consisting of columns (9-14 cm in diameter and 1-1.4 m in length) perpendicular to bedding and oval to polygonal in section

**comagmatic** (co-mag-mat'-ic) Said of igneous rocks that have a common set of chemical and mineralogic features, and thus are regarded as having been derived from a common parent magma. Also, said of the region in which such rocks occur. See also *con-sanguinity*

**Comanchean** (Co-man'-che-an) Lower Cretaceous of North America

**comb** 1 The crest of a mountain or hill, a mountain ridge. Syn *combe* 2 A vein filling in which subparallel crystals, generally of quartz, have grown perpendicular to the vein walls and thus resemble the teeth of a comb

**comber** (comb'-er) 1 A deep water wave with a high breaking crest pushed forward by a strong wind. It is much larger than a whitecap 2 A long-period *breaker* whose crest collapses gradually over a nearly flat bottom for a long distance, the water spilling down continuously over the advancing wave front, a spilling breaker

**commensalism** (com-men'-sal-izm) The relationship that exists between two organisms in which the first benefits from the second, the second being neither benefited nor harmed. Adj *commensal* Cf. *mutualism*, *symbiosis*

**commination** (com-mi-nu'-tion)

The reduction of a substance to a fine powder; pulverization. It may occur in nature, and is also a means of preparing stone, coal, or ore for direct use or further processing.

**common depth point** A portion of the subsurface that is involved in producing seismic reflections at different offset distances on several profiles. Abbrev: CDP. Syn: *common reflection point*.

**common-depth-point stack** A sum of seismic traces that have the same *common depth point*. The summing is done after appropriate statics and normal-moveout corrections have been applied to each trace. The objective is to attenuate noise and multiple reflections while accentuating reflection events.

**common lead** Any lead from a phase with a low value of U/Pb and/or Th/Pb such that no significant *radiogenic* lead has been generated in situ since the phase formed. Such phases include galena and other sulfides such as pyrite; feldspars, in particular K-feldspar; micas; and most abundant rock types of Cenozoic age. Data on common lead are used in determining ages and in solving genetic problems. Syn: *ordinary lead*.

**common salt** A colorless or white crystalline rock consisting almost entirely of the mineral *halite*. It occurs abundantly in nature as beds, in *salt domes*, and as crusts around the margins of *salt lakes*.

**community** (com-mu'-ni-ty) A group of organisms (living or fossil) occurring together because they possess an integrated food chain operating through several different feeding levels. Cf: *assemblage*; *association*, *biocoenosis*. Syn: *biotic community*.

**compactability** (com-pact'-a-bil'-i-ty) A property of a sedimentary material that permits it to decrease in volume or thickness under load; it is a function of the size, shape, hardness, and brittleness of the constituent particles.

**compaction** (com-pac'-tion) Reduction in bulk volume or thickness of fine-grained sediments, owing to increasing weight of overlying material that is continually being deposited, or to pressures resulting from earth movements. Tighter packing of sedimentary particles results in a decrease in porosity.

**compass** (com'-pass) 1. An instrument for determining directions, either a *magnetic compass* or a gyrocompass. 2. A simple drafting instrument for describing circles, transferring measurements, or subdividing distances.

**compensation point** (com-pen-sa'-tion) The point at which the color of a mineral in thin section between crossed Nicols is compensated (becomes dark gray) by the introduction of a quartz wedge.

**competence** (com'-pe-tence) The ability of a current of water or wind to transport detritus, in terms of particle size rather than amount, measured as the diame-



ter of the largest particle transported. It depends on velocity.  
Cf: *capacity*.

**competent** (com'-pe-tent) 1. Pertaining to the competence of a stream or current of air. 2. Said of a bed or stratum that is able to withstand the pressure of folding without flowage or change in original thickness. Competent strata form *parallel folds*.

**compilation** (com-pi-la'-tion) The selection and assembly of map detail from various source materials (such as existing maps, aerial photographs, surveys, and new data), and the preparation and production of a new or improved map based on this detail.

**complementary** (com-ple-men'-tary) 1. Said of different rocks or rock groups differentiated from a common magma, whose total composition is that of the parent magma. 2. Said of sets of fractures that are believed to be related although their origin is unknown.

**complex** (com'-plex) 1. A large-scale field association or assemblage of different rocks of any age or origin, having structural relations so intricately involved or otherwise complicated that the rocks cannot be readily differentiated in mapping; e.g. a "volcanic complex". See also: *basement*. 2. A rock-stratigraphic unit that includes a mass of structurally complicated rock, e.g. Crooks Complex (Precambrian) of central Arizona.

**complex ripple mark** *interference ripple mark*.

**complex spit** A large *recurved spit* with minor or secondary spits developed at its end. Example: Sandy Hook, N.J.

**component** (com-po'-nent) One of a set of chemical compositions of a thermodynamic system, the relative masses of which may be varied to describe all compositions within the system. Components are the minimum number of chemical units required to describe the phase-rule behavior of a system.

**componental movement** (com-po-nen'-tal) In the deformation of a rock, the relative movements of component or constituent particles.

**composite coast** (com-pos'-ite) An initial coast resulting from large-scale upwarping or subsidence along lines transverse to the coast. Upwarping produces coastal salients, whereas downwarping produces embayments.

**composite cone** *stratovolcano*.

**composite fault scarp** A dislocation of the land surface whose height results from the combined effects of faulting and differential erosion.

**composite fold** *compound fold*.

**composite grain** A sedimentary particle formed by aggregation of two or more discrete grains; esp. a carbonate particle resulting from clustering of lumps, pellets, coated grains, or detrital, skeletal, or algal particles.

**composite intrusion** Any igneous intrusion that is composed of two or more injections of different

chemical and mineralogical composition. Cf: *multiple intrusions*.

**composite profile** A plot consisting of the highest points of a series of *profiles* drawn along several regularly spaced parallel lines on a map; it represents the surface of any relief area as viewed in the horizontal plane of the summit levels from an infinite distance.

Cf: *projected profile*.

**composite topography** A landscape whose topographic features have developed in two or more cycles of erosion

**composition** (com-po-si'-tion) 1

The chemical constitution of a mineral. 2 The chemical or mineralogical constitution of a rock

**composition plane** A plane on which the two individuals of a contact twin are united. It is usually identical with the *twinning plane*.

**composition point** In a plot of phase equilibria, that point whose coordinates represent the chemical composition of a phase or mixture.

**compound alluvial fan** (com'-pound) *bajada*.

**compound coral** The skeleton of a colonial coral.

**compound eye** An eye of an arthropod, consisting essentially of a great number of minute eyes crowded together; e.g. the eye of a trilobite.

**compound fold** A fold upon which minor folds with similar axes have developed. Syn: *composite fold*.

**compound ripple mark** Ripple mark consisting of one set of rip-

ples modified by a differently oriented set.

**compound shoreline** A shoreline showing well-developed features of both a *shoreline of emergence* and a *shoreline of submergence*, e.g. where a formerly submerged shoreline is elevated slightly but not enough to destroy the effects of submergence.

**compound valley glacier** A glacier composed of two or more individual ice streams coming from different tributary valleys.

**compound vein** 1 A vein or lode consisting of a number of parallel fissures united by cross fissures, usually diagonally. 2 A vein composed of several minerals

**compound volcano** A volcano that consists of a complex of two or more cones, or one that has an associated volcanic dome, either in its crater or on its flanks. Examples are Vesuvius and Mont Pelée.

**compressibility** (com-pres'-si-bil'-i-ty) The change of volume and density under hydrostatic pressure. It is the reciprocal of *bulk modulus*. Syn: *modulus of compression*.

**compression** (com-pres'-sion) A system of forces or stresses that tends to decrease the volume of, or shorten, a substance; also, the change of volume produced by such a system of forces.

**compressional wave** (com-pres'-sion-al) *P wave*.

**compressive strength** (com-pres'-sive) The maximum *compressive stress* that can be applied to a

material, under given conditions, before failure occurs.

**compressive stress** A *normal stress* that tends to push together material on opposite sides of a real or imaginary plane. See also: *compressive strength*. Cf: *tensile stress*.

**concave cross-bedding** (con-cave')

1 Cross-bedding with concave (downward-arching), generally tangential, foreset beds. This very common type is used as a criterion for distinguishing top from bottom in sedimentary rocks. 2 Cross-bedding deposited on a lower concave surface, as in *festoon cross-bedding*.

**concentrates** (con'-cen-trates) The valuable fraction of an ore that is left after worthless material is removed in processing. Cf: *tailings*.

**concentric fold** (con-cen'-tric) *parallel fold*

**concentric weathering** *spheroidal weathering*

**conch** 1 The part of a cephalopod shell developed after the embryonic shell. 2. Any of various large spiral-shelled marine gastropods; also, the shell of such a conch. 3. Any of various shells of marine invertebrates, including bivalve mollusks and brachiopods.

**conchiolin** (con-chi-o'-lin [con-ki-o'-lin]) A fibrous nitrogenous substance that constitutes the organic basis of most mollusk shells.

**conchoidal** (con-choi'-dal [con-koi'-dal]) Said of a type of rock or mineral fracture that gives a

smoothly curved surface. Conchoidal fracture is characteristic of quartz and obsidian. Etymol: like the curve of a conch (sea-shell).

**concordant** (con-cor'-dant) 1. Said of a contact between an igneous intrusion and the country rock, which parallels the foliation or bedding of the latter. 2. Structurally conformable; said of strata displaying parallelism of bedding or structure. 3. Said of radiometric ages, determined by more than one method or by the same method from more than one mineral, that are in agreement.—Ant: *discordant*.

**concrete** A mixture of *cement*, an *aggregate*, and water, which will "set" or harden to a rocklike consistency.

**concretion** (con-cre'-tion) A hard, compact aggregate of mineral matter, subspherical to irregular in shape, formed by precipitation from water solution around a nucleus, such as a shell or bone, in a sedimentary or pyroclastic rock. Concretions are generally different in composition from the rock in which they occur, and represent a concentration of some minor constituent of that rock. Chert, iron oxide, and pyrite are among the common materials that form concretions. Cf: *accretion*; *nodule*.

**concretionary** (con-cre'-tion-a-ry) Characterized by, consisting of, or producing *concretions*.

**concussion fracture** (con-cus'-sion) One of a system of fractures

in individual grains of a rock which are generally radial to the grain surface and related to the contacts with adjacent grains. They are apparently formed by violent grain-to-grain contacts in the initial stages of *shock metamorphism*.

**condensate** (con-den'-sate) Liquid hydrocarbons, generally clear or pale straw-colored and of high *API gravity* (above 60°), that are produced with *wet gas*. Syn: *distillate*; *natural gasoline*.

**conditional resources identified subeconomic resources**

**conductivity** (con'-duc-tiv'-i-ty) 1. *electrical conductivity*. 2. *thermal conductivity*.

**conduit** (con'-duit) 1. A passage that is filled with water under hydrostatic pressure. 2. *volcanic conduit*.

**cone** 1. A steep-sided pile of sand, gravel, and sometimes boulders, with a fanlike outwash base, deposited against the front of a glacier by meltwater streams. 2. A *volcanic cone*. 3. A type of submarine fan-shaped deposit, esp. a deep-sea fan associated with a major active delta like that of the Mississippi, Nile, or Ganges.

**cone-in-cone structure** A structure in thin, calcareous shale layers that resembles a set of nested cones with apexes downward; generally of fibrous calcite. The cone axes are normal to the bedding and are 10 mm to 10 cm long. The structure appears to be due to pressure aided by crystallization and solution. Syn: *cone-in-*

*cone*.

**Conemaughian** (Co-ne-maugh'-i-an) Upper Middle Pennsylvanian of eastern United States.

**cone of depression** A depression in the potentiometric surface of a body of ground water, which has the shape of an inverted cone and develops around a well from which water is being withdrawn. Cf: *drawdown*.

**cone sheet** A dike that is arcuate in plan and dips at 30°-45° toward the center of the arc. Cone sheets occur in concentric sets, which presumably converge at a magmatic center. They are commonly associated with *ring dikes*.

**confined aquifer** An aquifer bounded above and below by impermeable beds, or by beds of distinctly lower permeability than that of the aquifer itself; an aquifer containing confined ground water. Syn: *artesian aquifer*.

**confined ground water** Ground water that is under sufficient pressure to rise above the level at which it is encountered in a well; it may or may not flow to or above the ground surface. Its upper surface is the bottom of an impermeable bed. Ant: *unconfined ground water*. Syn: *artesian water*.

**confining bed** A body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers. Cf: *aquitard*; *aquifuge*; *aquiclude*.

**confining pressure** An equal, all-sided pressure, e.g. *geostatic pressure* or *hydrostatic pressure*.

**confluence** (con'-flu-ence) The point where two streams or two glaciers meet.

**confluence plain** A plain formed by the merging of the valley floors of two or more streams.

**confluence step** A rock step that rises upstream toward the heads of two glacial valleys at their place of confluence. It is probably caused by the strengthening of glacial action downvalley from that point.

**conformability** (con-form'-a-bil'-i-ty) The quality or condition of being conformable; *conformity*.

**conformable** (con-form'-a-ble) 1. Said of strata characterized by an unbroken sequence in which the layers are formed one above the other in parallel order by uninterrupted deposition; also, said of the contacts between such strata. Cf: *unconformable*. 2. Said of the contact of an intrusive body when it is aligned with the intrusion's internal structures. Cf: *concordant*.

**conformal projection** (con-for'-mal) A map projection on which the shape of any very small area of the surface mapped is preserved unchanged on the map and the scale at any point is the same in every direction although it may vary from point to point. Examples: *Mercator projection*; *Lambert conformal conic projection*. Cf: *equal-area projection*.

**conformity** (con-form'-i-ty) 1. The relationship between adjacent sedimentary strata that have been deposited in orderly sequence

with little or no evidence of time lapse; true stratigraphic continuity. Syn: *conformability*. 2. A surface that separates younger strata from older ones, along which there is no physical evidence of erosion or nondeposition, and no significant hiatus.—Cf: *unconformity*.

**conglifraction** (con-gel'-i-frac'-tion) The mechanical disintegration, splitting, or breakup of a rock or soil due to the great pressure exerted by the freezing of water contained in cracks or pores, or along bedding planes. Syn: *frost splitting*; *frost weathering*; *frost wedging*.

**congluturbation** (con-gel'-i-turba'-tion) The stirring and churning of soil, resulting from frost action; it involves heaving, solifluction, and differential and mass movements, and produces patterned ground. Syn: *cryoturbation*.

**congeneric** (con-ge-ner'-ic) Belonging to the same genus.

**conglomerate** (con-glom'-er-ate) A coarse-grained clastic sedimentary rock, composed of rounded to subangular fragments larger than 2 mm in diameter (granules, pebbles, cobbles, boulders) set in a fine-grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay; the consolidated equivalent of gravel. Etymol: Latin *conglomeratus*, "heaped, rolled, or pressed together". Cf: *breccia*. Syn: *puddingstone*.

**conglomeratic** (con-glom'-er-at'-ic) Pertaining to a conglomerate, composed or having the properties of conglomerate.

**congruent fold** (con'-gru-ent) A parasitic fold, the axis and axial surface of which are parallel to the axis and axial surface of the main fold to which it is related.

**congruent melting point** The temperature at a specified pressure at which a solid phase changes to a liquid phase of the same composition

**conical fold** (con'-i-cal) A fold model that can be described geometrically by the rotation of a line about one of its ends, which is fixed. Cf: *cylindrical fold*

**conic projection** One of a group of map projections produced by projecting the geographic meridians and parallels onto the surface of a cone that is tangent to, or intersects, the surface of the sphere, and then developing (unrolling and laying flat) the cone as a plane. True distances are measured along the line of tangency; everywhere else on the map the scale is too large or too small. Examples: *Lambert conformal conic projection*; *Albers projection*. See also: *polyconic projection*.

**conifer** (co'-ni-ier) A gymnosperm, a member of the class Coniferae, having needlelike or scalelike leaves and naked seeds borne in cones. Conifers include pines, firs, and spruces.

**coniferous** (co-nif'-er-ous) Bearing cones, as in conifers.

**conjugate** (con'-ju-gate) 1. Said of

faults that are of the same age and depositional episode. 2. Said of a joint system in which the sets are related in deformational origin; also, said of the mineral deposits that may form in such joints.

**conjugate solutions** Two solutions coexisting in equilibrium whose compositions are separated by a miscibility gap in a potentially continuous compositional field. The possibility of a critical point at which the two phases would become identical is implicit.

**conjugation line** The line connecting the composition points of two immiscible liquids that are in equilibrium with each other.

**connate water** (con'-nate) Water entrapped in the interstices of a sedimentary rock at the time the rock was deposited. The term is commonly misused by reservoir engineers and well-log analysts to mean any water in the voids of a rock, i.e. *formation water*. Syn: *fossil water*, *native water*

**conodont** (co'-no-dont) One of a large number of small, disjunct fossil elements assigned to the order Conodontophorida, phosphatic in composition, and commonly toothlike in form but not in function; produced in bilaterally paired, serial arrangement by small marine animals of uncertain affinity. Range, Cambrian (possibly Late Precambrian) to Upper Triassic.

**conoscope** (co'-no-scope) A polarizing microscope using convergent light with the Bertrand lens inserted, used to test the interfer-

ence figures of crystals.

**Conrad discontinuity** (Con'-rad) A discontinuity in some areas of the earth's crust, commonly at a depth of 17-20 km, at which velocities increase from  $\approx 6.1$  km/sec to 6.4-6.7 km/sec.

**consanguinity** (con-san-guin'-i-ty) The genetic relationship between igneous rocks that are presumably derived from a common parent magma. Such rocks are closely associated in space and time and ordinarily have similar chemical and mineralogical characteristics. Adj: *consanguineous*. See also *comagmatic*.

**consequent** (con'-se-quent) adj. 1 Said of a geologic or topographic feature that originated as a result of and in harmony with pre-existing conditions or features; e.g. a consequent ridge formed by an anticlinal arch. 2 Said of a stream or valley whose course is dependent on the general form and slope of an existing land surface.—n. *consequent stream*.

**consequent fault scarp** A fault scarp which has been changed by mass-wasting shortly after its initial formation.

**consequent stream** A stream which follows a course that is a direct consequence of the original slope of the surface on which it developed.

**consolidation** (con-sol'-i-da'-tion) 1. Any process whereby loose, soft, or liquid earth materials become firm and coherent, e.g. the cooling of a lava or the cementation of a sand. 2. The adjust-

ment of a soil in response to increased load, e.g. the squeezing of water from the pores.

**conspecific** (con-spe-cif'-ic) Belonging to the same species.

**constructional** (con-struc'-tion-al) Owing its form or general character to upbuilding processes, such as accumulation by deposition or by volcanic extrusion. Ant: *destructional*.

**contact** (con'-tact) n. 1. The surface between two types or ages of rock. 2. The surface between two fluids in a reservoir, i.e. oil and gas, oil and water, or gas and water. Syn: *interface*.—adj. Said of a mineral deposit that occurs at the contact of two unlike rock types. **contact deposit** A mineral deposit formed between two unlike rocks, esp. at the contact between a sedimentary and an igneous rock.

**contact metamorphism** Reconstitution of rocks that takes place at or near their contact with a body of igneous rocks and is genetically related to its intrusion. Cf: *thermal metamorphism*. See also: *exomorphism*; *endomorphism*.

**contact metasomatism** A mass change in the composition of rocks in contact with an invading magma. "Fluid" constituents from the magma are carried out to combine with some of the country-rock constituents to form a new suite of minerals.

**contact mineral** A mineral formed by contact metamorphism.

**contact twin** A twinned crystal, the two individuals of which are symmetrically arranged about a

twin plane.

**contact zone aureole.**

**contemporaneous deformation** (con-tem'-po-ran'-e-ous) Deformation that takes place in sediments during or immediately following their deposition. It includes many varieties of soft-sediment deformation, such as small-scale crumpling and brecciation. Syn: *penecontemporaneous deformation*.

**contemporaneous fault growth fault.**

**continent** (con'-ti-nent) One of the earth's major land masses, including both dry land and continental shelves. At present continents constitute about one-third of the earth's surface.

**continental** (con-ti-nen'-tal) Formed on land rather than in the sea. Continental deposits may be of lake, swamp, wind, stream, or volcanic origin.

**continental apron** *continental rise*. **continental basin** A region in the interior of a continent comprising one or more closed basins.

**continental borderland** That area of the *continental margin* between the shoreline and the continental slope which is topographically more complex than the *continental shelf*. It is characterized by ridges and basins, some of which are below the depth of the continental shelf. An example is the southern California continental borderland.

**continental crust** The crustal rocks that underlie the continents; they are equivalent to the *sial*, and

range in thickness from about 35 km to as much as 60 km under mountain ranges. The density of the upper layer of the continental crust is  $\approx 2.7 \text{ g/cm}^3$ , and the velocities of compressional seismic waves through it are less than  $\approx 7.0 \text{ km/sec}$ . Cf: *oceanic crust*.

**continental deposit** A sedimentary deposit laid down on land or in bodies of water not directly connected with the ocean, as opposed to a marine deposit; a glacial, fluvial, lacustrine, or eolian deposit formed in a nonmarine environment. See also: *terrestrial deposit*.

**continental displacement** *continental drift*.

**continental divide** A drainage divide that separates streams flowing toward opposite sides of a continent.

**continental drift** The concept that large plates of continental (sialic) crust have moved freely across a substratum of oceanic (simatic) crust, much as ice can drift through water. Proposed by the German meteorologist Alfred Wegener in 1912, the concept has been largely superseded by other theories, esp. *plate tectonics*. Syn: *continental displacement*.

**continental glacier** An ice sheet covering a large part of a continent, as in the Antarctic. Syn: *ice sheet*.

**continental margin** The various provinces between the shoreline and the abyssal ocean floor, including the *continental shelf*, *continental borderland*, *continental*



*slope, and continental rise.*

**continental nucleus shield.**

**continental platform continental shelf.**

**continental rise** That part of the *continental margin* between the continental slope and the abyssal plain. It is a gentle incline with a generally smooth topography, although it may bear submarine canyons. Syn. *continental apron.*

**continental shelf** That part of the *continental margin* that is between the shoreline and the continental slope (or, when there is no noticeable slope, a depth of 200 m). It is characterized by its very gentle slope of 0.1°. Cf: *insular shelf; continental borderland.*

Syn. *continental platform; shelf.*

**continental slope** That part of the *continental margin* that is between the continental shelf and the continental rise (or oceanic trench). It is characterized by its relatively steep slope of 3-6°. Cf: *insular slope.*

**continuous deformation** (con-tin'-u-us) Deformation by flow rather than by fracture. Cf: *discontinuous deformation.*

**continuous permafrost** A zone of permafrost that, for the most part, is uninterrupted by pockets or patches of unfrozen ground. Cf: *discontinuous permafrost; sporadic permafrost.*

**continuous profiling** A seismic method in which geophone groups are placed uniformly along the length of the line and so spread that a uniformly spaced set of points in the subsurface is sam-

pled once.

**continuous reaction series** A *reaction series* in which early-formed crystals react with later liquids without abrupt phase changes; e.g. the plagioclase feldspars form a continuous reaction series. Cf: *discontinuous reaction series.*

**contorted bedding convolute lamination.**

**contour** n. 1. An imaginary line, or a line on a map or chart, that connects points of equal value, e.g. elevation of the land surface. Contours are commonly used to depict topographic or structural surfaces, but they can readily show any phenomenon that can be quantified. Cf: *form line.* See also: *structure contour.* Syn: *isopleth; contour line.* 2. The outline or configuration of a surface feature seen two-dimensionally, e.g. the contour of a mountain pass or a coastline.—v. To provide a map with contour lines; to draw a contour line.

**contour current** An ocean current flowing along lines of equal water density, approximately parallel to the bathymetric contours.

**contour diagram** An equal-area projection of structural data in which the poles have been contoured according to their density per unit area on the projection. Its purpose is to obtain easier visualization of the results of a petrofabric study.

**contour interval** The difference in value between two adjacent contours, e.g. the vertical distance between the elevations represented

by two successive contour lines on a topographic map. It is generally a regular unit chosen according to the amount and abruptness of the change involved and the scale of the map.

**contourite** (con'-tour-ite) Any contour-current deposit, esp. a layer of fine sand or coarse silt in a marine-mud sequence, deposited on the continental rise by contour-following bottom currents.

**contour line** A line on a map representing a contour. Present usage makes contour and contour line synonymous.

**contour map** A map that portrays the configuration of the land surface by means of contour lines; esp. a topographic map that shows surface relief by contours drawn at regular intervals above mean sea level, or a structure-contour map that shows the configuration of a specified rock surface underground and its inferred configuration where it has been removed by erosion.

**controlled mosaic** A mosaic in which the photographs or images have been adjusted, oriented, and scaled to horizontal ground control in order to provide an accurate representation with respect to distances and distortions. It is usually assembled from photographs that have been corrected for tilt and for variations in flight altitude.

**conulariid** (co-nu-lar'-i-id) A group of extinct marine animals that had chitinous, pyramidal or flattened conical shells with

marked quadrilateral symmetry. Generally considered as an order of the Coelenterata. Range, Middle Cambrian to Lower Triassic.

**convection** (con-vec'-tion) 1. In hydrothermal systems, the flow of waters around and through heated zones adjacent to plutons in response to thermal gradients. 2. The transfer of heat by vertical movements in the atmosphere, owing to density differences caused by heating from below. 3. A general term for the density-driven movement and mixing of water masses within the ocean. 4. A supposed mass movement of subcrustal or mantle material, either laterally or in *convection cells*. Convection currents have been invoked to explain deep-sea trenches, island arcs, orogeny, and the like.

**convection cell** In tectonics, a pattern of mass movement of mantle material in which the central area is uprising and the outer area is downflowing, due to heat variations. See also: *convection*.

**convergence** (con-ver'-gence) 1. The meeting of ocean currents or water masses, resulting in the sinking of the denser, colder, or more saline water; also, the line or area where this occurs. Cf: *divergence*. 2. The gradual decrease in vertical distance between two sedimentary rock units or horizons as the result of thinning of intervening strata. 3. The acquisition or possession of similar characteristics by animals or plants of different groups, as a result of

similarity in habitat or environment; *convergent evolution*.

**convergence map** *isochore map*.

**convergent evolution** (con-ver'-gent) The development of similar-appearing forms in genetically unrelated lineages: *convergence*. Cf: *parallel evolution*; *homeomorphy*.

**converted wave** A seismic wave that has been converted from a P-wave to an S-wave or vice versa by reflection or refraction at an interface. Such waves are sometimes designated PS or SP. Cf: *reflected wave*.

**convolute** (con'-vo-lute) Coiled or wound together, as in a gastropod shell whose inner whorls are entirely concealed by the outer whorls. Cf: *involute*.

**convolute bedding** *convolute lamination*.

**convolute lamination** Intricately crumpled or folded laminae, esp. of silt or fine sand, that are confined within an undeformed layer, die out both upward and downward, and are overlain and underlain by parallel undisturbed layers. The structure appears to result from deformation during deposition. Syn: *convolute bedding*; *contorted bedding*; *convolution*.

**convolution** (con-vo-lu'-tion) 1. The process of producing convolute bedding, also, the state or structure of being convoluted. 2. A change in the shape of seismic waves as they pass through the earth or other *filter*. It can be calculated in the mathematical operation called "linear superposi-

tion".

**coordinates** (co-or'-di-nates) Linear or angular quantities (usually two-dimensional) which designate the position that a point occupies in a given plane or other surface in relation to a given reference system; e.g. latitude and longitude are coordinates of a point on the earth's surface.

**coordination number** (co-or'-di-na'-tion) In crystallography, the number of nearest neighbor ions that surround a given ion in the crystal structure, e.g. four, six, or eight.

**copper** (cop'-per) A reddish or salmon-pink isometric mineral, the native metallic element Cu. It is ductile and malleable, a good conductor of heat and electricity, usually dull and tarnished, and formerly an important ore.

**coprolite** (cop'-ro-lite) The fossilized excrement of vertebrates such as fishes, reptiles, and mammals. Coprolites are larger than *fecal pellets*, measuring up to 20 cm in length, are brown or black in color, and are often composed largely of calcium phosphate.

**coquina** (co-qui'-na [ko-kee'-na]) A detrital limestone composed of broken, abraded shell fragments, which is weakly to moderately cemented; esp. relatively recent deposits occurring in Florida. Cf: *microcoquina*. Etymol: Spanish, "cockleshell".

**coral** (cor'-al) 1. A general name for any of a large group of bottom-dwelling, attached, marine coelenterates of the class An-

thozoa. They are common in warm modern seas and abundant in the post-Cambrian fossil record, produce external skeletons of calcium carbonate, and exist as solitary individuals or grow in colonies. 2. The hard calcareous external skeleton secreted by coral polyps for their support and habitation, and found in single specimens growing plantlike on the sea bottom or in extensive solidified accumulations (coral reefs).

**coralgal** (cor-al'-gal) Said of a firm carbonate rock formed by an intergrowth of frame-building corals and algae. The material so formed is an excellent sediment binder in a coral reef.

**coralline** (cor'-al-line) Pertaining to, composed of, or having the structure of corals, as coralline limestone.

**corallite** (cor'-al-lite) The calcareous exoskeleton formed by an individual coral polyp, consisting of walls, septa, and accessory structures such as tabulae and dissepiments. It may be embedded in the general structure of the coral colony or it may be solitary. Cf: *corallum*.

**corallum** (co-ral'-lum) The calcareous exoskeleton of a coral colony, or the *corallite* of a solitary coral; the entire skeleton of a coral. Pl: *coralla*.

**coral reef** 1. A coral-algal or coral-dominated mound or ridge of in-place coral colonies and skeletal fragments, carbonate sand, and organically secreted calcium car-

bonate. A coral reef is built up around a potentially wave-resistant framework, especially of coral colonies but often including many algae. 2. A popular term for an *organic reef* of any type.

**coral rock** Limestone of a coral reef.

**cordierite** (cor'-di-er-ite) A blue orthorhombic mineral,  $(\text{Mg,Fe})_2\text{Al}_4\text{Si}_5\text{O}_{18}$ . It is a common mineral of metamorphic rocks.

**cordillera** (cor-dil-le'-ra) 1. An extensive series of more or less parallel ranges of mountains (together with their associated valleys, basins, plains, plateaus, rivers, and lakes), the component parts having various trends but the mass itself having one general direction; esp. the great mountain region of western North America from the eastern face of the Rocky Mountains to the Pacific Ocean, or the Andes in South America. 2. An individual *mountain chain*, e.g. one of the parallel chains of the Rocky Mountains. 3. A term used in South America for an individual *mountain range*.—Ety-mol: Spanish, "chain or range of mountains", from Latin *chorda*, "cord".

**core** 1. The central part of the earth, beginning at a depth of about 2900 km, probably consisting of iron-nickel alloy; it is divisible into an outer core that may be liquid and an inner core about 1300 km in radius that may be solid. 2. A cylindrical section of rock, usually 5-10 cm in diameter and up to several meters in length,

taken by a core bit and brought to the surface for examination and/or analysis. 3. A vertical section of ocean-bottom sediment collected by a coring device. 4. A mass of impervious material, e.g. clay, forming the central part of an embankment, dike, or dam. 5. The inner or central part of a fold, esp. of a folded structure that includes some sort of structural break. Cf: *envelope*. 6. *reef core*

**core barrel** A hollow cylinder attached to a specially designed bit and used to obtain and preserve a continuous section or core of the rocks penetrated in drilling.

**core test** A hole drilled with a core drill for the purpose of securing geological information.

**Coriolis force** (Co-ri-o'-lis) The apparent force caused by the earth's rotation which serves to deflect a moving body on the surface of the earth to the right in the northern hemisphere and to the left in the southern. Cf: *pole-fleeing force*. See also: *Ferrel's law*.

**corner** (cor'-ner) A point on a land boundary at which two or more surveyed lines intersect, e.g. section corner or township corner.

**corona** (co-ro'-na) 1. A zone of minerals, usually with radial arrangement, around another mineral. The term has been applied to reaction rims, corrosion rims, and originally crystallized minerals. 2. The main part of the calcareous test of an echinoid.

**corrasion** (cor-ra'-sion) 1. *abrasion*. 2. A term sometimes used as a syn. of *attrition*. Verb: *corrade*.

**correlate** (cor'-re-late) To show correspondence in character and stratigraphic position between such geologic phenomena as formations or fossil faunas of two or more separated areas.

**correlation** (cor-re-la'-tion) 1. Demonstration of the equivalence of two or more geologic phenomena in different areas; it may be lithologic or chronologic. Also, the condition or fact of being correlated. 2. Identification of a phase of a seismic record as representing the same phase on another record; also, the measurement of the degree of linear relationship between a pair of traces, or of the extent to which one can be considered as a linear function of the other. 3. The intensity of the association or interdependence between two or more mathematical variables.

**corrie** (cor'-rie) A term used in Scotland as a syn. of *cirque*. Etymol: Gaelic *coire*, "kettle". Also spelled: *corry*.

**corrosion** (cor-ro'-sion) 1. Erosion of rocks by chemical processes, e.g. solution, hydrolysis, hydration, oxidation. Cf: *corrasion*. Verb: *corrode*. 2. The partial resorption, dissolution, fusion, or other modification of the outer parts of early-formed crystals, or of xenoliths, by the solvent action of the residual magma in which they are contained. See also: *corrosion border*.

**corrosion border** One of a series of borders of one or more secondary minerals around an original crys-

tal, representing the modification of a phenocryst due to the corrosive action of its magma. Cf: *corona*. See also: *corrosion rim*.

**corrosion rim** A *corrosion border* as seen in section.

**corundum** (co-run'-dum) A mineral,  $Al_2O_3$ . It occurs as grains and masses, or as variously colored rhombohedral crystals, including the gem varieties ruby and sapphire. Corundum is extremely tough and has a hardness of 9 on the Mohs scale. See also: *emery*.

**cosmic dust** (cos'-mic) 1. Very fine particles of solid matter moving about in interplanetary space or elsewhere in the universe. 2. The smallest particles that invade the earth's atmosphere from interplanetary space. Their composition and structure are similar to those of meteorites.

**cosmic erosion** The degradation or destruction of rocks on a planetary surface as a result of shock-wave interactions produced by hypervelocity impacts of particles. The term includes the gradual wearing-away of rock surfaces due to spalling, as well as the catastrophic rupture and breakup of entire rocks.

**cosmic radiation** Very high-energy subatomic particles from outer space, which bombard the earth's atmosphere. Primary cosmic rays (atomic nuclei) are almost completely absorbed in the upper atmosphere; secondary cosmic rays, which have less energy, may reach the earth's surface, providing a part of natural background radia-

tion.

**cosmochemistry** (cos'-mo-chem'-is-try) The study of the origin, distribution, and abundance of elements in the universe.

**cosmogony** (cos-mog'-o-ny) Speculation regarding the origin of the universe, including that of the earth. Cf: *cosmology*.

**cosmology** (cos-mol'-o-gy) The study, both theoretical and observational, of the space-time structure of the universe as a whole. Cf: *cosmogony*.

**cosmopolitan** (cos-mo-pol'-i-tan) Said of a kind of organism or a species that is widely distributed throughout the world in various geographic and ecologic provinces. Noun: *cosmopolite*.

**coteau** (co-teau') A word used in the U.S. for a variety of features, e.g. hills or a hilly upland, an elevated rough plain, a low ridge within a swampy area, or esp. a prominent dissected escarpment forming the edge of a plateau, as in the north-central U.S. Etymol: Canadian French. "slope of a hill".

**cotectic** (co-tec'-tic) Said of conditions of temperature, pressure, and composition under which two or more solid phases crystallize simultaneously from a single liquid over a finite range of falling temperature; also, said of the geometric line or surface representing the corresponding phase boundary on the liquidus of a phase diagram.

**cotton ball** *ulexite*.

**cotylosaur** (cot-y'-lo-saur) Mem-

ber of an order of reptiles (Cotylosauria) of generalized structure and lizardlike or turtlelike habit, mostly of late Paleozoic age. Range, Lower Pennsylvanian to Upper Triassic.

**cotype** (co'-type) A term originally used for either a *syntype* or a *paratype*; not recommended because of this dual meaning.

**coulee** (cou'-lee [koo'-lee]) 1. In the northwestern U.S., a dry or intermittent stream valley, esp. a long trenchlike gorge that once carried meltwater from an ice sheet, e.g. the Grand Coulee in Washington state. 2. A tongue-like mass of debris moved by solifluction. 3. A flow of viscous lava with a blocky, steep front.—Etymol: French, "flow, outflowing".

**coulee lake** A lake formed when a lava flow acts as a dam across a stream valley.

**couloir** (cou-lour' [kool-wahr']) 1. A deep, narrow valley; esp. a gorge or gully on a mountain side in the Alps. 2. A French term for a passage in a cave, or a vertical cleft in a cliff.—Etymol: French, "passage".

**country rock** The rock enclosing or traversed by a mineral deposit, e.g. a vein system, or by an igneous intrusion. Cf: *wall rock*.

**coupled wave** A type of *surface wave* that is continuously generated by another wave which has the same phase velocity. Syn: *C wave*.

**cove** 1. A small sheltered bay or inlet in a coast, often affording anchorage for small craft. 2. A

hollow in a steep mountainside, or a small valley extending down a mountain, as in the foothills of the Blue Ridge in Virginia. 3. A term used in the southern Appalachian Mountains for an open area sheltered by hills or mountains, e.g. Cades Cove, Tennessee.

**covellite** (co'-vel-lite) An indigo-blue hexagonal mineral: CuS. It is a common secondary mineral and represents an ore of copper.

**crag** A steep, rugged rock; a rough broken cliff or projecting point of rock.

**crag and tail** A streamlined hill or ridge, resulting from glaciation and consisting of a knob of resistant bedrock (the "crag"), with an elongate body (the "tail") of more erodible bedrock, till, or both, on its lee side.

**crater** (cra'-ter) 1. A basinlike, rimmed structure at the top or on the flanks of a volcanic cone; it is formed by explosion or collapse. 2. A saucer-shaped pit or depression on the earth's surface, resulting from impact or explosion. 3. *lunar crater*.

**crater lake** A lake, generally of fresh water, formed by the accumulation of rain and ground water in a volcanic crater or caldera.

**craton** (cra'-ton) A part of the earth's crust that has attained stability and has been little deformed for a long time. The term is restricted to continents, and includes both *shield* and *platform*. Cf: *hedreocraton*.

**creek** 1. A term used generally in

the U.S. (except New England) for any stream larger than a brook but smaller than a river. 2. A tidal inlet or estuary, esp. on a low-lying coast.

**creep** 1. The slow, imperceptible downslope movement of mineral, rock, and soil particles under gravity. 2. Continuously increasing, slow deformation (strain) of solid rock resulting from a small constant stress acting over a long period of time. 3. Gradual strain failure of rock, as in mine pillars and roofs, owing to the weight of overlying rocks.

**creep recovery** The gradual recovery of elastic strain when stress is released. Syn: *elastic aftereffect*.

**crenulation** (cren-u-la'-tion) Small-scale folding (wavelength up to a few millimeters) that is superimposed on larger-scale folding. Crenulations may occur along the cleavage planes of a deformed rock.

**crescent beach** (cres'-cent) A curving beach, concave toward the sea, formed along a hilly or mountainous coast at a bayhead or at the mouth of a stream entering a bay.

**crescentic fracture** (cres-oen'-tic) A crescent-shaped mark on a glaciated rock surface, in the form of a hyperbolic crack, of larger size (up to 10-12 cm long) than a *chatemark*; it is convex toward the direction from which the ice moved and consists of a single fracture without removal of any rock. Cf: *crescentic gouge*. Syn: *crescentic crack*.

**crescentic gouge** A crescent-shaped mark in the form of a groove or channel with a somewhat rounded bottom, formed by glacial plucking on a bedrock surface; it is concave toward the direction from which the ice moved and it consists of two fractures from between which rock has been removed. Cf: *crescentic fracture*. Syn: *gouge mark*.

**crest** 1. The highest point on a hill or mountain, or the highest line along a ridge or range. 2. The highest point on a given stratum in any vertical section through an anticline. Cf: *crest line*. 3. The highest part of a wave.

**crest line** The line joining the highest points on a given stratum in an anticline. Cf: *crest*.

**crest plane** Planar *crest surface*.

**crest surface** A surface that connects the *crest lines* of the beds of an anticline. Cf: *crest plane*.

**Cretaceous** (Cre-ta'-ceous) The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago; also, the corresponding system of rocks. It is named after the Latin word for chalk ("creta") because of the English chalk beds of this age.

**crevasse** (cre-vasse') 1. A deep fissure or crack in a glacier, caused by stresses resulting from differential movement over an uneven surface. Crevasses may be as much as 100 m deep. 2. A crack or breach in the bank of a river, esp.



in a natural levee or artificial embankment of the lower Mississippi River. 3. A deep break or fissure in the earth after an earthquake.—Etymol: French.

**crevice** (crev'-ice) 1. A narrow opening or recess, as in a wave-eroded cliff. 2. A shallow fissure in the bedrock under a gold placer, in which small but highly concentrated deposits of gold may be found. 3. A colloquial syn. of *crevasse*.

**crinoid** (cri'-noid) An echinoderm of the class Crinoidea, characterized by a globular body enclosed by a *calyx* from which "arms" extend radially, and by a jointed flexible stem and a "root" by which it is attached to the sea bottom. Range, Ordovician to the present. Informal syn: *sea lily*.

**crinoidal limestone** (cri-noid'-al) A rock consisting almost entirely of the fossil skeletal parts of crinoids, esp. the plates of the stem.

**crystalite** (cris-to'-bal-ite) A mineral:  $\text{SiO}_2$ . It is a high-temperature polymorph of quartz and tridymite, and occurs as white octahedrons in acidic volcanic rocks. Crystalite is stable only above  $1470^\circ\text{C}$ . Cf: *tridymite*.

**critical angle** (crit'-i-cal) The smallest angle of incidence at which there is total reflection when an optic, acoustic, or electromagnetic wave passes from one medium to another medium that is less refractive.

**critical point** A point representing a set of conditions (pressure, temperature, composition) at which

two phases become physically indistinguishable; in a system of one component, the temperature and pressure at which a liquid and its vapor become identical in all properties.

**critical pressure** The pressure required to condense a gas at the critical temperature, above which, regardless of pressure, the gas cannot be liquefied.

**critical temperature** That temperature above which a substance can exist only in the gaseous state, no matter what pressure is exerted.

**critical velocity** Most commonly, that velocity at which fluid flow changes from laminar to turbulent. As used by hydrological engineers, the term has several other meanings.

**crocidolite** (cro-cid'-o-lite) A blue asbestiform variety of riebeckite, occurring in silky fibers and in massive and earthy forms. Syn: *blue asbestos*.

**Croixan** (Croix'-an) Upper Cambrian of North America.

**crop out** v. *outcrop*.

**cross-bedding** 1. *Cross-stratification* in which the cross-beds are more than 1 cm in thickness. 2. A cross-bedded structure, a cross-bed.—See also: *current bedding*. Syn: *false bedding*.

**cross-correlation** 1. A measure of the similarity of two seismic wave forms, the degree of linear relationship between them, or the extent to which one is a linear function of the other. 2. A method for comparison of two strings or sequences of numerical data. Cf:

*correlation.*

**crosscut** 1. A small passageway that may be driven at an angle to the main entry or an air course. 2. A level driven across the course of a vein or across the general direction of the workings; thus, a mine opening that intersects a vein or ore-bearing structure at an angle.

**crossed nicols** In a polarizing microscope, two Nicol prisms or Polaroid plates that are oriented so that the transmission planes of polarized light are at right angles; light that is transmitted from one will be intersected by the other, unless there is an intervening substance.

**crossed twinning** Repeated twinning after two laws, as in microcline. Syn. *gridiron twinning*.

**cross fault** 1. A fault that strikes diagonally or perpendicularly to the strike of the associated strata or to the general structural trend. 2. A minor fault that intersects a major fault.

**cross fiber** Veins of fibrous minerals, esp. asbestos, in which the fibers are at right angles to the walls of the vein. Cf. *slip fiber*.

**cross-lamination** 1. *Cross-stratification* characterized by cross-beds that are less than 1 cm in thickness. 2. A cross-laminated structure; a *cross-lamina*.

**crossopterygian** (cros'-sop-te-ryg'-i-an) n. A member of an order of lobe-finned bony fishes, the ancestors of the first land animals. The Crossopterygii include the *coelacanth*s. —adj. Of or pertaining to the lobe-finned fishes.

*cross ripple mark interference ripple mark.*

**cross section** 1. A diagram showing the features transected by a vertical plane, e.g. a vertical section through an orebody, an anticline, or a fossil. Cf. *longitudinal section*. Syn: *transverse section*. 2. An actual exposure or cut that shows transected geologic features. —Adj: *cross-sectional*.

**cross-stratification** Arrangement of strata inclined at an angle to the main stratification. In modern usage, this is considered to be the general term, and to have two subdivisions: *cross-bedding*, in which the cross-strata are thicker than 1 cm, and *cross-lamination*, in which they are thinner than 1 cm. See also: *current bedding*. Syn: *false stratification*; *diagonal stratification*.

**crude oil** *Petroleum* in its natural state as it emerges from a well, or after passing through a gas-oil separator but before refining or distillation.

**crush breccia** A breccia formed essentially in place by mechanical fragmentation as a result of folding or faulting. Cf. *crush conglomerate*; *autoclastic*. Syn: *cataclasite*; *tectonic breccia*.

**crush conglomerate** A rock formed essentially in place by folding or faulting of brittle, closely jointed rocks, containing lozenge-shaped fragments produced by granulation of rotated blocks and rounded by attrition, and closely simulating a normal sedimentary conglomerate; a rock similar to a

*crush breccia* but having fragments that are more rounded. Syn *cataclasite*; *tectonic conglomerate*.

**crushing strength** The compressive stress necessary to cause a solid to fail by fracture

**crust 1** The outermost layer of the earth, that part of the earth above the Mohorovičić discontinuity, made up of *sial*, or of *sial* and *sim*. It represents less than 0.1% of the earth's total volume. See also *continental crust*, *oceanic crust*. **2** A laminated, crinkled algal deposit, slightly arched to bulbous, formed on rocks or fossils by accretion or flocculation

**crustacean** (crus-ta'-cean) Any arthropod of the superclass Crustacea, characterized chiefly by the presence of two pairs of antennae. Most forms are marine. Crustaceans are second only to insects in numbers of individuals. Range, Cambrian to present

**crustified** (crust'-i-fied) Said of a vein in which the mineral filling is deposited in layers on the wall rock. Syn *healed*.

**Cryogenic period** An informal designation for a period in geologic history when large bodies of ice formed at or near the poles and the climate was generally suitable for the growth of continental glaciers

**cryolite** (cry'-o-lite) A white or colorless monoclinic mineral  $\text{Na}_3\text{AlF}_6$ . It has been found chiefly in a pegmatite at Ivigtut, Greenland. Natural and synthetic cryolite is used in the manufacture of alumi-

num. Syn *Greenland spar*.

**cryology** (cry-ol'-o-gy) *glaciology*. **cryoluminescence** (cry'-o-lu-mi-nes'-cence) Low-temperature increase of weak luminescence, or its production in normally non-fluorescent material

**cryomorphology** (cry'-o-morphol'-o-gy) The part of geomorphology pertaining to the various processes and products of cold climates

**cryopedology** (cry'-o-pe-dol'-o-gy) The study of the processes of intensive frost action and the occurrence of frozen ground, esp permafrost, including the civil-engineering methods used to overcome or minimize the difficulties involved

**cryoplanation** (cry'-o-pla-na'-tion) The reduction of a land surface by processes associated with intensive *frost action*, supplemented by the actions of running water, moving ice, and other agents. Cf *altiplanation*, *equiplanation*.

**cryosphere** (cry'-o-sphere) The part of the earth's surface that is perennially frozen, the zone of the earth where ice and frozen ground are formed

**cryoturbation** (cry'-o-tur-ba'-tion) *congeliturbation*

**cryptalgal** (crypt-al'-gal) Said of rocks or rock structures formed through the sediment-binding and carbonate-precipitating activities of nonskeletal algae. The influence of these organisms is more commonly inferred than observed, hence the etymol: Greek *kryptos*, "hidden, secret", + *al-*

gal.

**cryptocrystalline** (cryp'-to-crys'-tal-line) Said of the texture of a rock consisting of crystals that are too small to be recognized and distinguished under the ordinary microscope; indistinctly crystalline. Also, said of a rock with such a texture Cf: *microcrystalline*.

**cryptoexplosion structure** (cryp'-to-ex-plo'-sion) A nongenetic descriptive term to designate a roughly circular structure formed by the sudden, explosive release of energy and exhibiting intense, often localized rock deformation with no obvious relation to volcanic or tectonic activity. Many cryptoexplosion structures are believed to be the results of hypervelocity impact of crater-forming meteorites of asteroidal dimensions; others may have been produced by obscure volcanic activity. The term largely replaces the earlier term, cryptovolcanic structure.

**cryptoperthite** (cryp'-to-perth'-ite) An extremely fine-grained intergrowth of potassic and sodic feldspar in which the lamellae are detectable only by means of X-rays or with the aid of the electron microscope. Cf: *perthite*; *microperthite*.

**cryptovolcanic structure** (cryp'-to-vol-can'-ic) A term originally applied to a deformed, brecciated, generally circular structure believed to have been produced by volcanic explosions, but lacking any direct evidence of volcanic activity. Many of these structures

are now believed to have been formed by meteorite impact, and the nongenetic term *cryptoexplosion structure* is preferred.

**Cryptozoic** (Cryp-to-zo'-ic) That part of geologic time represented by rocks in which evidence of life is only slight and of primitive forms Cf: *Phanerozoic*.

**cryptozoon** (cryp-to-zo'-on) 1 A structure in Precambrian rocks, believed to be the remains of primitive organisms 2 A hemispherical or cabbage-like algal structure of variable size, produced by the problematical Cambrian and Ordovician reef-forming calcareous alga of the genus *Cryptozoon*. —Pl: *cryptozoa*.

**crystal** (crys'-tal) A homogeneous, solid body of a chemical element, compound, or isomorphous mixture, having a regularly repeating atomic arrangement that may be outwardly expressed by plane faces.

**crystal axis** One of three imaginary lines in a crystal (four in a hexagonal crystal) that pass through its center; it is used as a reference in describing crystal structure and symmetry. One or all of the crystal axes may coincide with axes of symmetry. Syn: *crystallographic axis*.

**crystal chemistry** The study of the relations among chemical composition, internal structure, and the physical properties of crystalline matter.

**crystal class** One of the 32 possible combinations of the nontranslational elements of crystal symme-

try, divided among the six crystal systems. Syn: *point group*.

**crystal flotation** The floating of light-weight crystals in a body of magma. Cf. *crystal settling*.

**crystal form** 1. The geometric shape of a crystal 2. An assemblage of symmetrically equivalent crystal planes making up a form which displays the symmetry of a crystal class A crystal may be bounded by one or more forms, each consistent with the internal symmetry of the crystal.

**crystal fractionation** *Magmatic differentiation* resulting from the settling-out of crystals as they form Cf. *fractional crystallization*

**crystal gliding translation gliding.**

**crystal habit** The general shape of crystals, e.g. cubic, prismatic, fibrous. For a given type of crystal, the habit may vary from locality to locality depending on environment of growth.

**crystal lattice** The regular and repeated three-dimensional arrangement of atoms or ions in a crystal. See also. *Bravais lattice; space lattice*.

**crystalline** (crys'-tal-line) Of or pertaining to the nature of a crystal; having regular molecular structure. Ant. *amorphous*.

**crystalline rock** 1. A rock consisting of minerals in an obviously crystalline state. 2. An inexact general term for igneous and metamorphic rocks as opposed to sedimentary.

**crystallinity** (crys-tal-lin'-i-ty) 1. The degree to which a rock (esp.

an igneous rock) is crystalline (*holocrystalline, hypocristalline, etc.*). 2. The degree to which the crystalline character of an igneous rock is developed (*macrocrystalline, microcrystalline, or crypto-crystalline*) or is apparent (*phaneritic or aphanitic*).

**crystallization** (crys'-tal-li-za'-tion) The process by which matter becomes crystalline, from a gaseous, fluid, or dispersed state

**crystallization differentiation** The progressive change in composition of the liquid fraction of a magma as a result of the crystallization of mineral phases that differ in composition from the magma.

**crystallization interval** 1. The interval of temperature (or, less frequently, pressure), between the formation of the first crystal and the disappearance of the last drop of liquid from a magma upon cooling, usually excluding late-stage aqueous fluids. 2. More specifically, when referring to a given mineral, the range or ranges of temperatures over which that particular phase is in equilibrium with liquid In the case of equilibria along reaction lines or reaction surfaces, crystallization intervals as thus defined include temperature ranges where certain solid phases are actually decreasing in amount with decrease in temperature.—Syn. *freezing interval*.

**crystallization magnetization**  
*chemical remanent magnetization.*  
**crystallizing force** (crys'-tal-liz-

ing) The expansive force of a crystal growing in a solid medium; force is different in different crystallographic directions.

**crystalloblast** (crys'-tal-lo-blast) A crystal of a mineral produced entirely by metamorphic processes. See also: *idioblast*; *holoblast*; *xenoblast*. Adj: *crystalloblastic*.

**crystalloblastesis** (crys'-tal-lo-blas'-te-sis) Deformation accomplished by metamorphic recrystallization.

**crystalloblastic** (crys'-tal-lo-blas'-tic) 1. Pertaining to a *crystalloblast*. 2. Said of a crystalline texture produced by metamorphic recrystallization under conditions of high viscosity and directed pressure, in contrast to igneous rock textures that are the result of successive crystallization of minerals under conditions of relatively low viscosity and nearly uniform pressure. See also: *homeoblastic*; *heteroblastic*.

**crystallography** (crys-tal-log'-ra-phy) The study of crystals, including their growth, structure, physical properties, and classification by form.

**crystal mush** Partially crystallized magma

**crystal optics** The science of the transmission of light in crystals

**crystal sandstone** 1. A sandstone in which the quartz grains have been enlarged by composition of silica so that the grains show regenerated crystal facets and sometimes nearly perfect quartz euhedra. Crystal sandstones of this nature sparkle in sunlight. 2.

A sandstone in which calcite has been deposited in the pores in large patches or units having a single crystallographic orientation, resulting in a "poikiloblastic" effect. See also: *sand crystal*. **crystal sedimentation** *crystal settling*.

**crystal seeding** The use of a seed crystal or foreign particle in a solution to initiate crystallization of the solute.

**crystal settling** In a magma, the sinking of crystals due to their greater density, sometimes aided by magmatic convection. It results in crystal accumulation, which develops *layering*. Cf: *crystal flotation*. Syn: *crystal sedimentation*.

**crystal structure** The orderly and repeated arrangement of atoms in a crystal, the translational properties of which are described by the crystal lattice or space lattice. Syn: *crystalline structure*.

**crystal system** One of six groups or classifications of crystals according to the symmetry of their crystal faces, and having characteristic dimensional equivalences in the lattices or axes of reference. The systems are: *isometric*, *hexagonal*, *tetragonal*, *orthorhombic*, *monoclinic*, and *triclinic*. Within the six systems there is a total of 32 crystal classes

**crystal tuff** An indurated deposit of volcanic ash dominantly composed of crystals or crystal fragments. Cf: *lithic tuff*.

**crystal zone** Three or more non-parallel crystal faces, the edges of

intersection of which are parallel to a common line or lattice row called the *zone axis*.

**cube** A crystal form in the isometric system enclosed by six symmetrically equivalent faces at right angles to one another.

**cubic cleavage** Mineral cleavage parallel to the faces of a cube; e.g. in galena.

**cubic packing** The "loosest" systematic arrangement of uniform spheres in a clastic sediment or crystal lattice, characterized by a unit cell that is a cube whose eight corners are the centers of the spheres involved. An aggregate with cubic packing has the maximum porosity (47.64%). Cf: *rhombohedral packing*. See also: *open packing*.

**cubic system** *isometric system*.

**cueta** (cues'-ta) An asymmetrical ridge, with a long gentle slope on one side conforming with the dip of the underlying strata, and a steep or clifflike face on the other side formed by the outcrop of the resistant beds. Etymol: Spanish, "hill, sloping ground". Cf: *hogback*. Syn: *wold*.

**cul-de-sac** (cul-de-sac') A cavern passage that has only one entrance.

**culm** A vernacular term variously applied, according to the locality, to carbonaceous shale, or to fine particles of anthracite coal.

**culmination** (cul-mi-na'-tion) The highest point of a structural feature, e.g. of a dome, anticline, or nappe. The axis of an anticline may have several culminations

that are separated by saddles. See also: *crest*. Syn: *apex*.

**culture** (cul'-ture) The details of a map, representing the works of man (such as roads, railroads, buildings, canals, trails, towns, and bridges), as distinguished from natural features; they are usually printed in black on a topographic map. The term also includes political boundary lines, meridians, parallels, place names, and the legends.

**cumulate** (cu'-mu-late) n. An igneous rock formed by the accumulation of crystals that settle out from a magma by the action of gravity.

**cumulative curve** (cu'-mu-la-tive) A *frequency curve* in which each group is added to the preceding one until the total number of observations is included, it adds to 100%. Syn: *cumulative frequency distribution*.

**cumulo dome** (cu'-mu-lo) *volcanic dome*.

**cumulo-volcano** *volcanic dome*.

**cup coral** *solitary coral*.

**cupola** (cu'-po-la) 1. An upward projection of an igneous intrusion into its roof. Cf: *roof pendant*. 2. A vaulted dome in certain radialarians.

**cupriferous** (ku'-prif'-er-ous) Copper-bearing.

**cuprite** (cu'-prite) A red isometric mineral:  $\text{Cu}_2\text{O}$ . It is an important ore of copper. Syn: *red copper ore*; *ruby copper*.

**cuprous** (cu'-prous) Of, pertaining to, or containing copper.

**Carle's law** The statement that

magnetic susceptibility is inversely proportional to absolute temperature. It is applicable to substances which do not show spontaneous magnetic order at low temperatures.

**current 1.** The concentrated flowing of water, air, or other fluid. **2.** A large stream of ocean water moving continuously in about the same path, and distinguished from the water through which it flows mainly by differences in temperature and salinity. See also: *ocean current*.

**current bedding** Any bedding or bedding structure produced by current action; specif. cross-stratification resulting from water or air currents of variable direction.

**current cross ripple mark** A bedding feature resulting from the intersection at any angle of a pre-existing current ripple mark by a later current moving in a different direction and being so weak and short-lived as not to destroy the first set of ripples.

**current mark 1.** Any feature formed by the action of a water current on a sedimentary surface, e.g. a *tool mark* or *scour mark*. **2.** An irregular feature made by a tidal current in the beach zone, consisting of a small depression extending toward the shore from the lee side of an obstruction. **3.** A *linguoid ripple mark*.

**current ripple mark** An *asymmetrical ripple mark*, formed by currents of air or water moving more or less constantly in a uniform di-

rection over a sandy surface, the ripple slowly migrating downcurrent much like a miniature sand dune. Cf. *oscillation ripple mark*. Syn: *current ripple*.

**curvature correction** (cur'-va-ture) An adjustment applied to an observation or computation (e.g. of difference in elevation) to allow for the earth's curvature. In geodetic leveling, the effects of curvature and of atmospheric refraction are considered together, and tables have been prepared from which combined corrections can be taken.

**cusp 1.** One of a series of sharp, seaward-projecting points of beach material, separated by shallow crescent-shaped troughs, spaced at more or less regular intervals along a beach face. See also: *beach cusp*. **2.** The large main denticle located above the basal cavity of conodont elements.

**cusped** (cusp'-ate) Of or pertaining to cusps or the cusplike form, e.g. a cusped bar.

**cut and fill 1.** A process in which material eroded from one place by waves or streams is deposited nearby until the surfaces of erosion and deposition are continuous. Cf: *scour and fill*. **2.** A sedimentary structure consisting of a small erosional channel that is subsequently filled. **3.** In engineering, the excavation of earth material from one place and its deposition as compacted fill in an adjacent place, as in road-building.



**cutbank** The steep or overhanging slope on the outer side of a meander curve, opposite the *slip-off slope*. It is produced by lateral erosion of the stream.

**cutoff** 1. A new and relatively short channel formed when a stream cuts through the neck of an oxbow or horseshoe bend, thus shortening its channel, also, a cut artificially constructed to straighten a channel or bypass a large bend. 2. An impermeable wall or collar placed beneath or within a dam, to prevent or retard seepage. 3. An arbitrary boundary, normal to the bedding, that marks the areal limit of a specific stratigraphic unit that is not defined by pinch-out or other natural features. Used in making maps and cross sections, it is in effect a specialized facies boundary.

**cutoff grade** The lowest grade of mineralized material that qualifies as ore in a given deposit, i.e., material of the lowest assay value that is included in an ore estimate.

**cutoff limit assay limit**

**cutoff spur** The remnant of a *meander spur*, formed when a vigorously downcutting stream breaks through a narrow strip of land between adjacent curves in the stream course; it usually stands as an isolated hill. Syn. *meander core*.

**cutout** A mass of shale, siltstone, or sandstone filling an erosional channel cut into a coal seam. Cf. *roll, horseback*.

**cut terrace** 1. *wave-cut terrace* 2. *rock terrace*

**cuttings well cuttings**

**cuvette** (cu-vette') A large-scale basin of sedimentation, as distinguished from a tectonic basin.

**Cuvier's principle** (Cu'-vi-er) The theory that certain very different characteristics of complex organisms are commonly associated, e.g. kinds of feet and teeth among the vertebrates.

**C-wave coupled wave**

**cycle** 1. A series of events that are repeated in the same order at regular intervals and that end under conditions that are the same as they were at the beginning, e.g. a *cycle of sedimentation*. 2. A sequence or succession of events that runs to completion, the last stage being quite different from the first, e.g. a *cycle of erosion*. 3. A group of rock units that occur repeatedly in a certain order through a sedimentary succession, esp. a *cyclothem*. — Adj. *cyclic*.

**cycle of denudation cycle of erosion**

**cycle of erosion** 1. The sequence of stages involved in the reduction of a recently uplifted land area to base level. The cycle, generally divided into youthful, mature, and old-age stages, is hypothetical because it is normally interrupted before it runs to completion. 2. The interval of time required for such a sequence cycle to be completed. — Syn. *geographic cycle; geomorphic cycle, physiographic cycle, cycle of denudation*.

**cycle of sedimentation** 1. A sequence of related processes and

conditions, repeated in the same order, that is recorded in a sedimentary deposit. 2. The deposition of sediments in a basin between the beginnings of two successive marine transgressions. 3. A *cyclothem*. —Syn: *sedimentary cycle*.

**cyclic evolution** (cy'-clíc) Evolution, supposed by some to have occurred in many lineages, involving successively (1) initial rapid and vigorous expansion, (2) a long stable or slowly changing phase, and (3) a final short episode in which overspecialized, degenerate, or inadaptable forms led to extinction.

**cyclic twinning** Repeated twinning of three or more individual crystals according to the same twin law but with the twinning axes or planes not parallel. It often results in threefold, fourfold, fivefold, sixfold, or eightfold twins, which, if equally developed, show symmetry not formed in single crystals. Cf: *polysynthetic twinning*.

**cyclosilicate** (cy'-clo-sil'-i-cate) A class or structural type of *silicate* characterized by the linkage of the  $\text{SiO}_4$  tetrahedra in rings, with a ratio of  $\text{SiO}:\text{O} = 1:3$ . An example of a cyclosilicate is beryl,  $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$ . Syn: *ring silicate*.

**cyclothem** (cy'-clo-them) A series

of beds deposited during a sedimentary cycle of the type that prevailed during the Pennsylvanian Period. Nonmarine sediments, often including bituminous coal, commonly occur in the lower half of a cyclothem, marine sediments in the upper half. Most cyclothem are incomplete. Cf: *ideal cyclothem*; *megacyclothem*.

**cylindrical fold** (cy-lin'-dri-cal) A fold model that can be described geometrically by the rotation of a line through space parallel to itself. Cf: *conical fold*.

**cylindrical projection** A projection on the surface of a cylinder; esp. any of numerous map projections of the earth, produced by projecting the geographic meridians and parallels onto the surface of a cylinder that is tangent to, or intersects, the surface of the sphere, and then developing (unrolling and laying flat) the cylinder as a plane. The principal scale is preserved along the line of tangency. Example: *Mercator projection*.

**Cyprus-type deposit** (Cy'-prus) A pyritic copper deposit associated with underlying serpentinite and pillow basalt and with overlying cherts and ferruginous sediments. It is thought to form on oceanic crust of the sea floor. Cf: *kuroko deposit*.

## D

**d** The spacing between successive identical planes in a crystal structure. The list of d's obtained by X-ray methods is characteristic of each substance and is widely used for mineral identification. See also: *d-spacing*.

**dacite** (da'-cite [day'-site]) A fine-grained extrusive rock with the same general composition as *andesite* but having a less calcic plagioclase and more quartz; according to many, it is the extrusive equivalent of *granodiorite*.

**dalles** (dalz) 1. The rapids in a deep, narrow stream confined between the rock walls of a canyon or gorge; e.g. The Dalles of the Columbia River where it flows over columnar basalt. 2. A steep-sided part of a stream channel, near the dalles proper, marked by clefts, ravines, or gorges; e.g. along the Wisconsin River, Wisc.—Etymol: French plural of *dalle*, "gutter". Syn: *dells*.

**darcy** (dar'-cy) A standard unit of permeability, equivalent to the passage of one cubic centimeter of fluid of one centipoise viscosity flowing in one second under a pressure differential of one atmosphere through a porous medium having an area of cross section of one square centimeter and a length of one centimeter. See also: *millidarcy*.

**Darcy's law** A derived formula for the flow of fluids on the assumption that the flow is laminar and

that inertia can be neglected. The numerical formulation of this law is used generally in studies of gas, oil, and water production from underground formations.

**dark mineral** Any one of a group of rock-forming minerals that are dark-colored in thin section, e.g. biotite, hornblende, augite.

**Darwinism** (Dar'-win-ism) The doctrine that organic evolution resulted from variation and the selection of favored individuals through *natural selection*.

**datum** (da'-tum) 1. A fixed or assumed point, line, or surface, in relation to which others are determined; any quantity or value that serves as a base or reference for other quantities or values. 2. The top or bottom of a bed of rock, or other surface, on which structure contours are drawn. Syn: *datum horizon*. —Pl: *datums*; "data" refers to a collection of facts, figures, or statistics.

**datum level** 1. Any level surface, such as mean sea level, used as a reference from which elevations are reckoned; a *datum plane*. 2. The base or top of a range of fossils that can be correlated over a wide area.

**datum plane** 1. A permanently established horizontal surface to which water depths, ground elevations, water-surface elevations, and tidal data are referred, esp. *mean sea level*. 2. In seismology, an arbitrary reference surface used to minimize or eliminate local topographic and near-surface effects, to which seismic times and,

velocity determinations are referred.—Syn: *reference plane*.

**daughter element** (daugh'-ter) An element formed from another by radioactive decay; e.g., radon is the daughter element of radium.

**Davalian** (Da-vis'-i-an) Pertaining to the "American" school of geomorphology, based on the teachings and writings of William Morris Davis (1850-1934); esp. said of the concepts of penuplanation and the cycle of erosion, and of the genetic method of landform description (structure, process, stage).

**dead cave** A cave in which there is no longer any moisture, and in which deposition and excavation have ceased.

**dead glacier** A glacier that is without an accumulation area or is no longer receiving material from one. Ant: *active glacier*.

**dead ground** Rock in a mine that must be removed in order to get at productive ground.

**dead line** The level above which a batholith is metalliferous and below which it is economically barren.

**dead sea** A body of water devoid of normal aquatic organisms, from which evaporites have been or are being precipitated. Type locality: Dead Sea in the Near East.

**death assemblage** *thanatocoenosis*.

**débochure** (de-bouch-ure' (de-booh-shure')) 1. The mouth of a river or channel. 2. *resurgence*.

**debris** (de-bris' (de-brée')) 1. Any surficial accumulation of loose material detached from rock

masses by decay and disintegration, mainly rock fragments and soil. Syn: *rock waste*. 2. The rock and soil material on or within a glacier, or pushed ahead of the glacier front. 3. Interplanetary material, ranging in size up to bodies many kilometers across and including cosmic dust, meteorites, comets, and asteroids. Etymol: French, *débris*.

**debris avalanche** The sudden movement downslope of the soil mantle on steep slopes, often caused by saturation from heavy rains.

**debris cone** 1. An *alluvial fan* with steep slopes, generally composed of coarse fragments. Syn: *alluvial cone*. 2. A conical mound of fine debris lying at the angle of repose on certain boulders moved by a landslide. 3. A cone or mound of ice or snow on a glacier, covered with a veneer of debris thick enough to protect the underlying material from ablation. Syn: *dirt cone*.

**debris fall** The relatively free collapse of weathered mineral and rock material from a steep slope or cliff, it is esp. common along the undercut banks of streams.

**debris flow** A moving mass of rock fragments, soil, and mud, more than half of the particles being larger than sand size. Slow debris flows may move less than 1 m per year; rapid ones reach 160 km per hour, as in the 1977 Huascaran flow in the Peruvian Andes. Cf: *mudflow*.

**debris line** *swash mark*.

**debris slide** The downward movement of predominantly unconsolidated and incoherent earth and rock debris in which the mass does not show backward rotation but slides or rolls forward, forming an irregular hummocky deposit resembling a moraine.

**decay** (de-cay') 1. *chemical weathering*. 2. *radioactive decay*. 3. The attenuation or loss of energy from wind-generated ocean waves as they pass into a region of lighter winds.

**decay constant** The fraction of a large number of atoms of a radioactive element which decays per unit time, generally denoted by the symbol  $\lambda$ .

**Deccan basalt** (Dec'-can) A fine-grained nonporphyritic tholeiitic lava covering an area of about 200,000 square miles in the Deccan region of southeast India and consisting essentially of labradorite, clinopyroxene, and iron oxides. The rock corresponds to, among others, the plateau basalts of the Pacific Northwest of the U.S.A. and the Thulean province of western Scotland, northeast Ireland, and Iceland.

**decke** (deck'-e) The German equivalent of *nappe*, sometimes used in the English-language literature.

**declination** (dec-li-na'-tion) The horizontal angle in any given location between true north and magnetic north. Syn: *magnetic variation*.

**decline curve** A graph of the decline in production of an oil or gas

well or group of wells. Production rate (ordinate) is plotted against time (abscissa). It is used to predict *ultimate recovery*.

**declinometer** (dec-li-nom'-e-ter) An instrument that measures magnetic *declination*.

**declivity** (de-cliv'-i-ty) 1. A slope that descends from a point of reference. Ant: *acclivity*. 2. A surface gradient; an inclination.

**décollement** (dé-collé'-ment) Detachment structure of strata owing to deformation, resulting in independent styles of deformation in the rocks above and below. It is associated with folding and with overthrusting. Etymol: French, "unsticking, detachment".

**decomposition** (de'-com-po-si'-tion) *chemical weathering*.

**deconvolution** (de'-con-vo-lu'-tion) A process designed to restore a wave shape to the form it is assumed to have had before it underwent a filtering action or *convolution*. It is a data-processing technique applied to seismic reflection and other data for the purpose of improving the visibility and resolution of reflected events.

**decrepitation** (de'-crep-i-ta'-tion) The breaking-up of a mineral, usually violently and noisily, when it is heated.

**dedolomitization** (de-do'-lo-mit'-i-za'-tion) A process resulting from metamorphism, wherein part or all of the magnesium in a dolomite or dolomitic limestone is used for the formation of magnesium oxides, hydrides, and

silicates (e.g. brucite, forsterite) and resulting in an enrichment in calcite.

**deduction** (de-duc'-tion) Reasoning from the general to the particular; inferring consequences from evidence; deriving applications from general principles. Ant: *induction*.

**deep n.** A clearly discernible depression of the ocean floor. The term is generally understood to apply to depths greater than 18,000 feet (3000 fathoms). Syn: *abyss*.

**deep coal** Coal that is far enough below the surface to require underground mining.

**deeper-pool test** A well located within the known limits of an oil or gas pool and drilled with the object of searching for new producing zones below the producing zone of the pool. Cf: *shallower-pool test*.

**deep-focus earthquake** An earthquake whose focus is at a depth of 300-700 km. Cf: *shallow-focus earthquake*; *intermediate-focus earthquake*. Syn: *deep earthquake*.

**deep scattering layer** A stratified area of marine organisms in the open ocean that scatters sound waves from an echo sounder. Syn: *false bottom*; *phantom bottom*.

**Deep Sea Drilling Project** A program sponsored by the U.S. Government, with the combined effort of major oceanographic institutions, to sample the ocean bottom at numerous places throughout the world using the

research vessel *Glomar Challenger*. Abbrev: DSDP.

**deep-seated** Said of geologic features and processes that originate or are situated at depths of one kilometer or more below the earth's surface; *plutonic*.

**deep-well disposal** Disposal of liquid waste by injection into wells, usually constructed especially for the purpose, that penetrate deep, porous and permeable formations containing mineralized ground water and confined vertically by relatively impermeable beds. The method is used for disposal of saline water brought to the surface in oil wells, and for disposal of a variety of liquid wastes from industrial processes. Syn: *deep-well injection*.

**defect lattice** A crystal lattice in which the expected systematic repetition is interrupted by an omission, an inclusion of an extra item, or the substitution of an unexpected item.

**deflation** (de-fla'-tion) The removal of material from a beach, desert, or other land surface by wind action.

**deflation basin** A topographic basin resulting from deflation. Cf: *blowout*.

**deflection** (de-flec'-tion) 1. A sharp change in the trend of a mountain chain. 2. A relatively spontaneous diversion of a stream, as by glaciation or volcanic action.

**deflection of the vertical** The angle at a given point on the earth between the vertical, defined by

gravity, and the direction of the normal to the reference ellipsoid through that point. It is sometimes referred to as *deviation*, or deflection of the plumb line.

**deformation** (de-for-ma'-tion) 1. A general term for the processes of folding, faulting, shearing, compression, or extension of rocks as a result of various earth forces. 2. *strain*.

**deformation ellipsoid strain ellipsoid**

**deformation fabric** The orientation in space of the components of a rock, produced by external stress. It results from rotation or movement of the minerals or other components under stress, or of the growth of new minerals in a common orientation controlled by stress conditions. Syn: *tectonic fabric*.

**deformation plane** In structural petrology, the unique symmetry plane that contains the *a* and *c* axes and is normal to the *b* axis. Syn: *ac-plane*.

**deformation twinning** Twinning produced by deformation and gliding within a crystal. Syn: *mechanical twinning*.

**deglaciation** (de'-glä-si-a'-tion) The uncovering of an area from beneath glacier ice as a result of melting.

**degradation** (deg-ra-da'-tion) The general lowering of the surface of the land by erosive processes, especially by the removal of material through erosion and transportation by flowing water. Cf: *denudation*.

**degree of freedom** (de-gree') The capability of variation of a system. The number of degrees of freedom may be defined as is the number of independent variables, e.g. temperature, pressure, and concentration in the different phases, which must be specified in order to define the system completely; or as the number of variables that may be changed independently without causing a change in phase. See also: *phase rule*.

**delayed runoff** Water from precipitation that sinks into the ground and discharges later into streams through seeps and springs; also, runoff delayed by any means, such as temporary storage in the form of snow and ice.

**delay time** In seismic refraction work, the additional time required to traverse any raypath over the time that would be required to traverse the horizontal component at highest velocity encountered on the raypath, as it refers to either the source or receiver end of the trajectory. See also: *intercept time*.

**deliquescent** (del-i-ques'-cent) Capable of becoming liquid by the absorption of water from the air.

**delta** (del'-tä) The nearly flat alluvial tract of land at the mouth of a river, commonly forming a triangular or fan-shaped plain resembling the Greek letter "delta,"  $\Delta$ , in plan view. It is crossed by many distributaries, and results from the accumulation of sediment supplied by the river.

Most deltas are partly subaerial and partly below water.

**deltagesosyncline** (del'-ta-ge'-o-syn'-cline) *exogesosyncline*.

**deltatic** (del-ta'-ic) Pertaining to or characterized by a delta; e.g. "deltatic sedimentation" or a "deltatic coast".

**delta lake** A lake formed along the margin of or within a delta, as by the building of bars across a shallow embayment or by the enclosure of part of the sea by the growth of deltaic deposits.

**delta plain** The level or nearly level surface composing the landward part of a large delta.

**demersal** (de-mer'-sal) *benthic*.

**dendrite** (den'-drite) A branching figure resembling a shrub or tree, produced on or in a mineral or rock by the crystallization of a foreign mineral, usually an oxide of manganese, as in the *moss agate*.

**dendritic** (den-drit'-ic) Said of a mineral that has crystallized in a branching pattern; pertaining to a *dendrite*. Syn: *arborescent*.

**dendritic drainage pattern** An arrangement of surface drainage in which the streams branch randomly at almost any angle, resembling in plan the branching habit of trees. It indicates that the underlying rocks offer uniform resistance to erosion. Cf: *pinnate drainage pattern*.

**dendrochronology** (den'-dro-chronol'-o-gy) The study and matching of *growth rings* of trees with the object of dating events in the recent past.

**dense** 1. Having its parts massed

or crowded together; close; compact. 2. Said of fine-grained, aphanitic rocks in which the grain size generally averages less than 0.05 to 0.1 mm. 3. Said of a rock or mineral with a relatively high specific gravity.

**density** (den'-si-ty) 1. The mass or quantity of a substance per unit volume, usually expressed in grams per cubic centimeter. 2. Any quantity per unit of volume or per unit area. 3. The quality of being dense, close, or compact.

**density current** A gravity-induced flow of air in air or of water in water, owing to density differences, e.g. from differences in temperature, salinity, or concentration of suspended particles. See also: *salinity current*; *turbidity current*, *nuée ardente*.

**density log** The *well log* curve of induced radioactivity showing the bulk density of rocks and their contained fluids. It is a *porosity log* of the wall-contact type.

**density stratification** The *stratification* of a lake produced as a result of density differences, the lightest layer occurring near the top and the heaviest at the bottom. It is usually brought about by temperature changes, but may also be caused by differences in the amount of dissolved material, as where a surface layer of fresh water overlies salt water. See also: *thermal stratification*.

**dentate** (den'-tate) Toothed, or having toothlike projections.

**denudation** (de-nu-dr'-tion) 1. The sum of the processes that result in



the wearing away or the progressive lowering of the earth's surface by weathering, mass wasting, and transportation; also the combined destructive effects of such processes. The term is wider in its scope than *erosion*, although it is commonly used as a syn. of that term. See also: *degradation*. 2. Strictly, the laying bare, uncovering, or exposure of bedrock or a designated rock formation through the removal of overlying material by erosion

**deoxidation sphere** (de'-ox-i-da'-tion) *bleach spot*.

**departure** (de-par'-ture) The projection of a line onto an east-west axis of reference. The departure is the difference of the meridian distances or longitudes of the ends of the line. It is east or positive ("easting") for a line whose azimuth is in the northeast or southeast quadrant; it is west or negative ("westing") for a line whose azimuth is in the southwest or northwest quadrant.

**departure curve** In *resistivity log* analysis, a graph of correction factors to be applied to recorded (apparent) log measurements of particular sonde design, to estimate "true" measurements under specific geometric and physical conditions.

**depauperate fauna** (de-pau'-per-ate) 1. A fossil assemblage with substantially reduced *diversity*. Syn: *impoverished fauna*. 2. A *dwarf fauna*.

**depergulation** (de'-per-ge-la'-tion) The act or process of thawing per-

manently frozen ground.

**depletion** (de-ple'-tion) The act of reducing or exhausting, as of natural resources.

**depletion allowance** A proportion of income derived from mining or oil production that is considered to be a return of capital not subject to income tax. It is a way of recognizing that mining or petroleum production ultimately exhausts the reserve.

**depocenter** (de'-po-cen-ter) An area or site of maximum deposition in a depositional *basin*.

**deposit** (de-pos'-it) n. 1. Earth material of any type that has accumulated through the activities of water, wind, ice, or other agents. Cf: *sediment*. 2. A *mineral deposit*. —v. To lay down or allow to fall through a natural process; to become precipitated.

**deposition** (dep-o-si'-tion) 1. The laying-down of rock-forming material by any natural agent, e.g. the mechanical settling of sediment from suspension in water. Cf: *sedimentation*. 2. The precipitation of mineral matter from solution, e.g. of quartz in veins.

**depositional magnetization** (dep-o-si'-tion-al) *depositional remanent magnetization*.

**depositional remanent magnetization** Remanent magnetization resulting from mechanical orientation of ferrimagnetic mineral grains along the ambient field during sedimentation. Syn: *depositional magnetization*.

**depression contour** A closed contour, inside of which the ground

or geologic structure is at a lower elevation than that outside, and distinguished on a map from other contour lines by hachures on the downslope or downdip side.

**depth** The vertical distance from a specified datum to the bottom of a body of water, or from the ground or derrick floor to the bottom of a well.

**depth ice** 1. *anchor ice*. 2. Small particles of ice formed below the surface of the sea when it is churned by wave action.

**depth of compensation** 1. According to the concept of *isostasy*, the depth above which rock material is brittle and below which there is a slow movement of plastic rock to adjust to changes in load. See also: *isostatic compensation*. Syn: *compensation level*. 2. The depth in the ocean at which the rate of photosynthesis equals the rate of respiration.

**depth section** A seismic section plotted with its vertical scale in depth units rather than time units.

**depth zone** One of the physico-chemical environments at various depths in the earth that give rise to different metamorphic phenomena. Cf: *epizone*; *mesozone*; *katazone*.

**deranged drainage pattern** A distinctively disordered arrangement of drainage in a recently glaciated area. The former system is effaced and the new system is characterized by wandering streams that flow into and out of lakes, by only a few short tributaries, and by ex-

tensive swampy areas between streams.

**desalination** (de'-sal-i-na'-tion) The removal of dissolved salts from sea water in order to make it potable. The most common method is distillation.

**desert** (des'-ert) A region with a mean annual precipitation of 10 inches or less, and so devoid of vegetation as to be incapable of supporting any considerable population. Four kinds may be distinguished: (1) polar deserts, marked by perpetual snow cover and intense cold; (2) middle-latitude deserts, in the basinlike interiors of the continents, such as the Gobi, characterized by scant rainfall and high summer temperatures; (3) trade-wind deserts, notably the Sahara, with negligible precipitation and large daily temperature range; and (4) coastal deserts, as in Peru, where there is a cold current on the western coast of a large land mass.

**desert crust** 1. A hard layer, containing calcium carbonate, gypsum, or other binding matter, exposed at the surface in a desert region. 2. *desert varnish*. 3. *desert pavement*.

**desert dome** A convex rock surface with uniform smooth slopes, representing the result of prolonged exposure of a mountain mass to desert erosion; e.g. Cima Dome in the Mojave Desert, Calif.

**desert pavement** A residual concentration of wind-polished, closely packed pebbles and other

rock fragments, mantling a desert surface where wind has removed all smaller particles, and usually protecting the underlying material from further deflation. See also: *lag gravel*; *boulder pavement*. Syn: *desert crust*; *desert armor*; *desert mosaic*.

**desert polish** 1. A smooth, shiny surface imparted to rocks of desert regions by windblown sand and dust. Syn: *wind polish*. 2. A term sometimes used as a syn. of *desert varnish*.

**Desert soil** A great soil group in the 1938 classification system, a group of zonal soils having a light-colored surface horizon overlying calcareous material and, commonly, a hardpan. It is developed under conditions of aridity, warm to cool climate, and scant scrub vegetation. These soils are now classified as Argids and Orthids.

**desert varnish** A thin dark shiny film, composed of iron oxide with traces of manganese oxide and silica, formed on the surface of pebbles, boulders, and rock outcrops in desert regions after long exposure. It is believed to be caused by exudation of mineralized solutions from within and deposition by evaporation on the surface. A similar appearance produced by wind abrasion is properly known as *desert polish*. Syn: *desert patina*; *desert lacquer*; *desert crust*.

**desiccation** (des-ic-ca'-tion) A complete or nearly complete drying-out or drying-up, such as may

result in the formation of evaporites from bodies of water in an arid region.

**desiccation breccia** A breccia formed where irregular dried-out and mud-cracked polygons have broken into angular fragments that have then been deposited with other sediments. Syn: *mud breccia*.

**desiccation conglomerate** A term that has been used for a conglomerate consisting of fragments eroded from a mud-cracked layer of sediment and rounded by transportation.

**desiccation crack** A crack in sediment, produced by drying; esp. a *mud crack*.

**desiccation polygon** *mud-crack polygon*.

**desilication** (de-sil-i-ca'-tion) 1. The removal of silica from a rock or magma by the breakdown of silicates and the freeing of silica, or by reaction between a body of magma and the surrounding wall rock. 2. The removal of silica from soils in a warm climate by the percolation of large amounts of rain water.

**Desmoinesian** (Des-moi-ne's-i-an) Upper Middle Pennsylvanian of North America.

**destructional** (de-struc'-tion-al) Said of a landform that owes its origin or general character to the removal of material by erosion and weathering, e.g. a mesa or canyon. Ant: *constructional*.

**detached core** (de-tach-ed') The inner bed or beds of a fold that become separated or pinched off

from their source due to extreme folding and compression.

**detail log** (de'-tail) An electric log of a well bore with a scale expanded beyond the conventional 1 inch per 100 feet of depth, made in order to portray more clearly minor variations in the formations penetrated by the hole.

**detector** (de-tec'-tor) 1. The component of a remote-sensing system that converts electromagnetic radiation into a signal that can be recorded. Syn: *radiation detector*.

2. *seismic detector*.

**detrital** (de-tri'-tal) Pertaining to or formed from *detritus*; esp. said of minerals occurring in sedimentary rocks, which were derived from pre-existing rocks either within or outside the basin of deposition. Cf: *clastic*; *allogenic*.

**detrital ratio** *clastic ratio*

**detritus** (de-tri'-tus) 1. Loose rock and mineral material produced by mechanical means, e.g. disintegration or abrasion, and removed from its place of origin. Cf: *debris*. 2. Any fine particulate debris of organic origin, e.g. plant detritus in coal.

**deuteric** (deu-ter'-ic) Referring to reactions between primary magmatic minerals and the water-rich solutions that separate from the same body of magma at a late stage in its cooling history. Syn: *epimagmatic*. See also: *autometamorphism*.

**developed reserves** (de-vel'-oped) Ore that has been exposed on three sides and for which tonnage and quality estimates have been

made; ore essentially ready for mining. Cf: *positive ore*; *proved reserves*. Syn: *measured reserves*, *ore in sight*.

**development** (de-vel'-op-ment) Preparation of a mining property so that an orebody can be analyzed and its tonnage and quality estimated. Development is an intermediate stage between *exploration* and *mining*.

**development well** A well drilled within the known or proved productive area of an oil field, with the expectation of obtaining oil or gas from the producing formation or formations in that field Cf: *exploratory well*.

**deviation** (de-vi-a'-tion) 1. The departure of a drilled hole from being straight. The hole may be vertical or inclined and the departure may be in any direction. Deviation may be undesirable, or intentional as in *directional drilling*. 2. The angle of departure of a well bore from the vertical. 3. *deflection of the vertical*.

**devitrification** (de-vit'-ri-fi-ca'-tion) Conversion of glass to crystalline material.

**devolatilization** (de-vel'-a-til'-i-za'-tion) The loss of volatile constituents and the resulting proportional increase in carbon content during *coalification*. It is a process of metamorphism; the higher the rank of coal, the higher the level of devolatilization.

**Devonian** (De-vo'-ni-an) A period of the Paleozoic era (after the Silurian and before the Mississippian), thought to have covered

the span of time between 400 and 345 million years ago; also, the corresponding system of rocks. It is named after Devonshire, England, where rocks of this age were first studied. See also: *age of fishes*.

**dextral** (dex'-tral) Pertaining, inclined, or spiraled to the right, specif. pertaining to the normal or clockwise direction of coiling of gastropod shells. Ant: *sinistral*.

**dextral fault** *right-lateral fault*.

**dextral fold** An asymmetric fold with the asymmetry of a Z as opposed to that of an S when seen in profile. The long limb is apparently offset to the right. Cf: *sinistral fold*.

**diabase** (di'-a-base) An intrusive rock consisting essentially of labradorite and pyroxene, and characterized by ophitic texture. In Great Britain this rock is called *dolerite*.

**diabasic** (di-a-bas'-ic) 1. Composed of or resembling diabase 2. A seldom-used textural term approximately synonymous with *ophitic*.

**diachronous** (di-ach'-ro-nous) Said of a rock unit that is of varying age in different areas or that cuts across time planes or biozones; e.g. a marine sand that was formed during an advance of a shoreline and becomes younger in the direction in which the sea was moving. Syn: *time-transgressive*. Cf: *synchronous*.

**diadochy** (di-ad'-o-chy) *ionic substitution*.

**diagenesis** (di-a-gen'-e-sis) 1. All

the changes undergone by a sediment after its initial deposition, exclusive of weathering and metamorphism. It includes those processes (such as compaction, cementation, replacement) that occur under conditions of pressure and temperature that are normal in the outer part of the earth's crust, and according to most US geologists it includes changes occurring after lithification. There is no universally accepted definition of the term, or of its delimitation, e.g. with metamorphism. Cf: *syngensis* 2. The geochemical processes or transformations that affect clay minerals before burial in the marine environment. Cf: *halmyrolysis*.

**diagnostic mineral** (di-ag-nos'-tic)

A mineral, such as olivine or quartz, whose presence in an igneous rock indicates whether the rock is undersaturated or oversaturated.

**diagonal fault** (di-ag'-o-nal) *oblique fault*.

**diagonal joint** A joint whose strike is oblique to the strike of the sedimentary strata, or to the cleavage plane of the metamorphic rocks, in which it occurs. Syn: *oblique joint*.

**diagonal-slip fault** *oblique-slip fault*.

**dialysis** (di-al'-y-sis) A method of separating compounds in solution or suspension by their differing rates of diffusion through a semipermeable membrane, some colloidal particles not moving through at all, some moving

slowly, and others diffusing quite readily. Cf: *osmosis*. See also: *electrodialysis*.

**diamagnetic** (di'-a-mag-net'-ic)

Having a small, negative magnetic susceptibility. All materials that do not show paramagnetism or magnetic order are diamagnetic. Typical diamagnetic minerals are quartz and feldspar. Cf: *paramagnetic*.

**diamond** (di'-a-mond) An isometric mineral, a crystalline form of carbon dimorphous with graphite. It is the hardest natural substance known (hardness of 10 on the Mohs scale). The gem diamond has exceptional brilliance and play of prismatic color when cut and polished. See also: *industrial diamond*.

**diamond bit** A rotary-drilling bit studded with diamonds (usually *bori*). It is used for drilling and coring in extremely hard rock.

**diamond drilling** A variety of rotary drilling in which *diamond bits* are used as the rock-cutting tool. It is a common method of prospecting for mineral deposits, esp. in development work where core samples are desired.

**diapir** (di'-a-pir) A dome or anticlinal fold, the overlying rocks of which have been ruptured by the squeezing-up of the plastic core material. Diapirs in sedimentary strata usually contain cores of salt or shale; igneous intrusions may also show diapiric structure. See also: *diapirism*. Syn: *piercement dome*.

**diapirism** (di'-a-pir-ism) The pierc-

ing or rupturing of domed or uplifted rocks by mobile core material, as a result of tectonic stresses, geostatic load, or igneous intrusion. The concept was first applied to salt structures, which are the most common type of diapir.

**diaspore** (di'-a-spore) A gray or yellowish orthorhombic mineral,  $\text{AlO}(\text{OH})$ , dimorphous with boehmite. It is found in bauxite deposits.

**diastem** (di'-a-stem) A depositional break of minor extent presumed to represent a hiatus of brief duration. It records little or no erosion before deposition was resumed.

**diastrophism** (di-as'-tro-phism) A general term for all movement of the crust produced by tectonic processes, including the formation of ocean basins, continents, plateaus, and mountain ranges. *Orogeny* and *epeirogeny* are major subdivisions. Adj: *diastrophic*. Syn: *tectonism*.

**diatom** (di'-a-tom) A microscopic single-celled aquatic plant related to the algae. It grows in both fresh and salt water. Diatoms secrete siliceous *frustules* in a great variety of forms, which may accumulate in sediments in enormous numbers. See also: *diatomite*.

**diatomaceous earth** (di'-a-to-ma'-ceous) *diatomite*.

**diatomite** (di-at'-o-mite) A light-colored soft siliceous sedimentary rock, consisting chiefly of opaline frustules of the *diatom*. Owing to its high surface area, absorptive

capacity, and chemical stability, diatomite has a number of uses. The term is generally reserved for deposits of commercial value. Syn: *diatomaceous earth*; *kieselguhr*.

**diatom ooze** A deep-sea siliceous ooze consisting of at least 30% diatom frustules.

**diatreme** (di'-a-treme) A breccia-filled volcanic pipe that was formed by a gaseous explosion.

**dibrancliate** (di-bran'-chi-ate [di-bran'-ki-ate]) *coleoid*.

**dichroism** (di'-chro-ism) *Pleochroism* that is indicated by two different colors. Adj: *dichroic*. Cf: *trichroism*.

**dichroscope** (di'-chro-scope) An instrument for observing pleochroism in minerals, especially gems.

**dickite** (dick'-ite) A well-crystallized clay mineral of the kaolin group. It has the same composition,  $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$ , as kaolinite and nacrite, but is structurally distinct. It usually occurs in hydrothermal veins.

**diductor muscle** (di'-duc-tor) A muscle that opens the valves in articulate brachiopods. The principal pair is commonly in the pedicle valve on either side of the *adductor muscles*.

**differential compaction** (dif-fer-en'-tial) Reduction in bulk volume of fine-grained sediments produced by uneven settling or by differing degrees of compactability.

**differential entrapment** The control of oil and gas migration and accumulation by selective trap-

ping in interconnected reservoirs. A trap filled with oil is an effective gas trap but a trap filled with gas is not an effective oil trap. As a result, gas may be trapped down-dip and oil updip.

**differential erosion** Erosion that occurs at irregular or varying rates, caused by differences in the resistance of surface materials. Weaker rocks are rapidly worn away, whereas more resistant rocks remain to form ridges, hills, or mountains.

**differential melting** Partial melting of a rock, resulting from differences in melting temperatures of its constituent minerals.

**differential pressure** The difference in pressure between the two sides of an orifice; between reservoir and sand-face pressure; between pressure at the bottom of a well and at the wellhead; between flowing pressure at the wellhead and that in the gathering line. Any difference in pressure between that upstream and downstream where a restriction to flow exists.

**differential thermal analysis** *Thermal analysis* carried out by uniformly heating a sample that undergoes chemical and physical changes, while simultaneously heating a reference material that undergoes no changes. The temperature difference between the sample and the reference material is measured as a function of the temperature of the reference material. Abbrev: DTA.

**differential weathering** Weather-

ing that occurs at different rates, as a result of variations in composition and resistance of rocks or differences in intensity of weathering, and usually resulting in an uneven surface.

**differentiation** (dif'-fer-en'-ti-a-tion) 1. *magmatic differentiation*. 2. *sedimentary differentiation*. 3. The processes by which planets and satellites develop concentric layers of different composition.

**diffraction** (dif-frac'-tion) 1. The process by which the direction of wave motion in any medium is modified by bending around an obstacle, e.g. the bending of a wave in a body of water around a breakwater or other object. 2. The generation and transmission of seismic wave energy in accordance with *Huygens' principle*, also, an event observed on seismic data produced by diffracted energy.

**diffraction pattern** The interference pattern of lines obtained when waves of rays, such as X-rays, light rays, or particle rays, are passed through a small opening or around the edge of a particle. Each substance has a characteristic diffraction pattern.

**diffraction spacing** *d-spacing*.

**diffusion** (dif-fu'-sion.) The spreading-out of molecules, atoms, or ions into a vacuum, fluid, or porous medium, in a direction tending to equalize concentrations in all parts of the system.

**digital** (dig'-it-al) Said of the representation of measured quantities in discrete or quantized units.

A digital system is one in which the information is stored and manipulated as a series of discrete numbers, as opposed to an *analog system*.

**digitation** (dig-i-ta'-tion) The emanation of subsidiary recumbent anticlines from a larger recumbent anticline.

**dike** 1. A tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks. Cf: *sill*. 2. *clastic dike*. 3. A wall or embankment built around a low-lying area to prevent flooding.

**dike set** A group of linear or parallel dikes. Cf: *dike swarm*.

**dike swarm** A group of dikes in radial, parallel, or en echelon arrangement. Their relationship with the parent plutonic body may not be directly observable. Cf: *dike set*.

**dike wall** A ridge, such as a *hogback*, consisting of a dike that formed in a more or less vertical crevice and was left standing after the rocks on either side were removed by erosion. Syn: *dike ridge*.

**dilatancy** (di-lat'-an-cy) An increase in bulk volume during deformation, caused by a change from close-packed structure to open-packed structure, accompanied by an increase in the pore volume.

**dilatational wave** (dil-a-ta'-tion-al) *P-wave*.

**dilation** (di-la'-tion) Deformation by a change in volume but not shape. Also spelled: *dilatation*.



**dilation vein** A mineral deposit in vein space formed by bulging of the walls, contrasted with veins formed by wall-rock replacement.

**diluvial** (di-lu'-vi-al) 1. Pertaining to, produced by, or resembling a flood, esp. the Noachian flood. 2. Pertaining to *diluvium*.

**diluvium** (di-lu'-vi-um) 1. An archaic term once applied to widespread surficial deposits that were believed to be produced by extraordinary floods of vast extent, esp. the Noachian Flood; these deposits are now known to be mostly *glacial drift*. 2. A general term used in continental Europe for Pleistocene glacial deposits, as distinguished from younger *alluvium*.

**dimensional orientation** (di-men'-sion-al) In rock deformation, a tendency for planar or linear fabric elements to be arranged in a preferred orientation or alignment.

**dimension stone** (di-men'-sion) Stone that is quarried or cut in accordance with required dimensions.

**dimorph** (di'-morph) One of the two forms of a crystalline chemical compound, or of an organism, showing *dimorphism*.

**dimorphism** (di-mor'-phism) 1. The crystallization in two crystal forms of the same chemical compound, e.g. pyrite and marcasite. 2. The characteristic of having two distinct forms in the same species, as male and female, megaspheric and microspheric stages.

**dinoflagellate** (din'-o-flag'-el-late)

A one-celled microscopic flagellated organism, chiefly marine and usually solitary, with resemblances to both animal and plant kingdoms. Certain dinoflagellates produce tests and cysts, which exist abundantly as fossils. Range, Triassic to the present.

**dinosaur** (di'-no-saur) Any reptile of the subclass Archosauria, distinguished from other reptiles especially by features of the pelvic bones. Dinosaurs were carnivorous or herbivorous, bipedal or quadrupedal, land-dwelling, and of moderate to very large size. Range, Triassic to Cretaceous.

**diocahedral** (di'-oc-ta-he'-dral) Said of a layered-mineral structure in which only two of the three available octahedrally coordinated positions are occupied. Cf: *trioctahedral*.

**diopside** (di-op'-side) A white to green mineral of the clinopyroxene group:  $\text{CaMg}(\text{SiO}_3)_2$ . It is found esp. as a contact-metamorphic mineral in crystalline limestones.

**diorite** (di'-o-rite) A group of plutonic rocks intermediate in composition between acidic and basic, characteristically composed of hornblende, oligoclase or andesine, pyroxene, and sometimes a little quartz; the approximate intrusive equivalent of *andesite*. Diorite grades into *monzonite* with an increase in the alkali feldspar content.

**dioxide** (di-ox'-ide) An oxide containing two atoms of oxygen per

molecule, e.g.,  $\text{MnO}_2$ ,  $\text{ZrO}_2$ .

**dip n.** 1. The angle that a stratum or any planar feature makes with the horizontal, measured perpendicular to the strike and in the vertical plane. See also: *true dip*; *apparent dip*. 2. The angle between a reflecting or refracting seismic wave front and the horizontal; also, the angle between an interface associated with a seismic event and the horizontal. 3. *magnetic inclination*. —v. To be tilted or inclined at an angle.

**dip calculation** Calculation of the dip of a reflecting interface from observations of the variation of the arrival time of seismic events as the observing point is moved. It is often associated with *migration*. See also: *moveout*.

**dip fault** A fault that strikes parallel with the dip of the strata involved Cf: *strike fault*; *oblique fault*.

**dip joint** A joint that strikes approximately perpendicularly to the strike of the bedding or cleavage Cf: *strike joint*.

**diploid (dip'-loid)** An isometric crystal form having 24 faces, each meeting the crystallographic axes at unequal distances.

**dipmeter (dip'-me-ter)** A finely detailed *resistivity log* whose curves can be correlated to measure depth offsets relative to each other. Along with simultaneous measurements of the caliper, inclination, and direction of the borehole, such measurements can be solved for dip and strike of the strata. The borehole curves and

the later graphic plot are both called *dipmeters*.

**dip needle** An obsolete type of magnetometer used for mapping high-amplitude magnetic anomalies. It consists of a magnetized needle pivoted to rotate freely in a vertical plane, with an adjustable weight on the south side of the magnet.

**dipole (di'-pole)** Two poles of opposite charge an infinitesimal distance apart.

**dip separation** The distance or *separation* of formerly adjacent beds on either side of a fault surface, measured along the dip of the fault. Cf: *dip slip*; *strike separation*.

**dip shift** The *shift* or relative displacement of the rock units parallel to the dip of a fault, but outside the fault zone itself. Cf: *dip slip*.

**dip shooting** A system of seismic surveying in which the primary concern is determining the dip and position of reflecting interfaces rather than in tracing such interfaces continuously.

**dip slip** The component of the movement or *slip* that is parallel with the dip of a fault. Cf: *strike slip*; *dip shift*.

**dip-slip fault** A fault on which the movement is parallel to the dip of the fault. Cf: *strike-slip fault*.

**dip slope** A slope of the land surface that conforms approximately with the dip of the underlying rocks; specif. the long, gently inclined face of a *cuesta*.

**dip throw** The component of the slip of a fault measured parallel

with the dip of the strata.

**dipyramid** (di-pyr'-a-mid) A crystal form consisting of two *pyramids* meeting base-to-base at a plane of symmetry.

**directional drilling** (di-rec'-tion-al)

The drilling of a well at controlled departures from the vertical and at controlled azimuths, often utilizing a *whipstock*. It is done to establish multiple wells from a single location such as an offshore platform, and for other purposes. Cf: *deviation*; *sidetracking*. Syn: *slant drilling*.

**directional log** A *well log* that shows the inclination of a borehole, and the direction of the inclination. It is usually obtained with the *dipmeter* log.

**direct runoff** (di-rect') The *runoff* reaching stream channels immediately after rainfall or snow melting.

**dirt cone** A glacial *debris cone*.

**disappearing stream** (dis-ap-pear'-ing) A surface stream that disappears underground in a sink.

**discharge** 1. The rate of stream flow at a given instant in terms of volume per unit of time. 2. *sediment discharge*.

**disconformable** (dis-con-form'-able) 1. Pertaining to a *disconformity*. 2. Said of the contact of an intrusive body that is not essentially parallel to the intrusion's internal structure. Cf: *discordant*.

**disconformity** (dis-con-form'-i-ty)

An *unconformity* between beds that are parallel. The tendency is to apply the term to erosional breaks that are represented else-

where by rock units of at least formational rank. See also: *paraconformity*.

**discontinuity** (dis'-con-ti-nu'-i-ty)

1. A surface at which seismic-wave velocities abruptly change; a boundary between seismic layers of the earth, e.g. the *Moho*. 2. Any interruption in sedimentation; an *unconformity*. 3. In structural geology, a surface separating two unrelated groups of rocks, e.g. a fault.

**discontinuous deformation** (dis-con-tin'-u-ous) Deformation by fracture rather than flow. Cf: *continuous deformation*.

**discontinuous reaction series** A *reaction series* in which reaction of early-formed crystals with later liquid represents an abrupt phase change; e.g. olivine, pyroxene, amphibole, and biotite form a discontinuous reaction series. Cf: *continuous reaction series*.

**discordance** (dis-cord'-ance) A lack of parallelism between adjacent strata.

**discordant** (dis-cord'-ant) 1. Said of a contact between an igneous intrusion and the country rock that is not parallel to the foliation or bedding of the latter. Cf: *disconformable*. 2. Structurally *unconformable*; said of strata lacking parallelism of bedding or structure. 3. Said of radiometric ages, determined by more than one method for the same sample or for coexisting minerals, that are in disagreement beyond experimental error. Ant: *concordant*. 4. Said of topographic fea-

tures that do not have the same or nearly the same elevation, e.g. a valley whose stream enters the main stream by a waterfall. Ant: *accordant*.

**discovery well** The first well to encounter gas or oil in a hitherto unproven area or at a hitherto unproductive depth; a successful *wildcat*, *outpost well*, *deeper-pool test*, or *shallower-pool test*.

**disequilibrium assemblage** (dis'-e-quib'-ri-um) An association of minerals not in thermodynamic equilibrium.

**disharmonic fold** (dis-har-mon'-ic) A fold that varies noticeably in profile form in the various layers through which it passes. Ant: *harmonic fold*.

**disintegration** (dis'-in-te-gra'-tion)  
1 A syn. of *mechanical weathering*; less commonly, a syn. of weathering in general. 2 The decomposition of vegetable matter to carbon dioxide and water. 3 *radioactive decay*.

**disjunctive fold** (dis-junc'-tive) A fold in which the more brittle strata have fractured and separated and the more plastic beds have flowed.

**dislocation** (dis-lo-ca'-tion) 1. A defect in a crystal lattice 2. *displacement*.

**dismembered river system** (dis-mem'-bered) A system consisting of a trunk river and tributaries, the lower part of which has been flooded by the sea. As a result, the streams that were formerly tributaries of the river enter the sea by separate mouths.

**disorder** (dis-or'-der) The random occupation of one atom site in a crystal by two or more different atoms of similar size and charge.  
**dispersed phase** (dis-persed') Solid material in the form of a colloid, suspended in a fluid referred to as the dispersion medium.

**dispersion** (dis-per'-sion) 1. The pattern of geographic distribution of individuals within a species. 2. The property of a transparent gemstone to separate white light into the spectral colors. 3. The differences in the optical constants of a given mineral for different wavelengths of transmitted light 4. Distortion of the shape of a seismic-wave train because of variation of velocity with frequency.

**dispersion pattern** The pattern of distribution of chemical elements, especially trace elements, in the wall rocks of an orebody or in the surface materials surrounding it. Cf: *hala*.

**disphenoid** (di-sphe'-noid) A closed crystal form consisting of two *sphenoids*, in which the two faces of the upper sphenoid alternate with those of the lower. Syn: *bisphenoid*.

**disphotic zone** (dis-phot'-ic) The zone in bodies of water where there is only dim light and little photosynthesis. Cf: *euphotic zone*; *aphotic zone*.

**displacement** (dis-place'-ment) A general term for the relative movement of the two sides of a fault, measured in any chosen direction, e.g. along a drift in a

mine; also, the specific amount of such movement. Syn: *dislocation*.

**displacement pressure** The minimum pressure required to force the entry of a nonwetting fluid into a porous medium saturated with a wetting liquid; specif., to force oil or gas from one water-filled pore to the next.

**disposal well** (dis-pos'-al) A well drilled or used for disposal of brines or other fluids in order to prevent contamination of the surface by such wastes.

**dissected** (dis-sect'-ed) Cut by erosion, esp. by streams. The term is commonly applied to plains in the process of erosion after an uplift.

**dissection** (dis-sec'-tion) The work of stream erosion in destroying a relatively even land surface by cutting ravines or valleys into it, generally as a result of regional uplift. Adj. *dissected*.

**disseminated ore** (dis-sem'-i-nat-ed) A scattered distribution of generally fine-grained metal-bearing minerals throughout a rock body, in sufficient quantity to make the deposit an ore.

**dissociation** (dis-so-ci-a'-tion) The breakdown of a substance into several others, as  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$  by heat, or  $\text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^-$  by solution in water.

**dissociation point** The temperature at which a compound breaks up reversibly to form two or more other substances, e.g.,  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ .

**dissociation temperature** A temperature point at which a given

dissociation presumably occurs; actually, it is usually a range, owing to variations in composition or pressure, and may refer merely to the temperature at which the rate of a given dissociation becomes appreciable under stated conditions.

**dissolution** (dis-so-lu'-tion) *solution*.

**dissolved-gas drive** (dis-solved') Energy within an oil pool, resulting from the expansion of gas liberated from solution in the oil. Cf. *gas-cap drive*; *water drive*.

**dissolved load** That part of the total *stream load* that is carried in solution. Syn. *dissolved solids*; *solution load*.

**dissolved oxygen** The amount of oxygen dissolved in water, in parts per million (ppm) by weight, or in milligrams per liter (mg/l).

**dissolved solids** 1 *dissolved load*.

2. The total amount of dissolved materials, organic and inorganic, contained in a sample of water.

**distal** (dis'-tal) 1. Said of an ore deposit formed at a considerable distance, e.g. tens of kilometers, from the volcanic source from which its constituents have been derived. 2. Said of a sedimentary deposit of fine clastics formed far from the source area. 3. In fossils, remote or away from the point of attachment, plane of reference, or point of view.—Ant: *proximal*.

**distillation** (dis-til-la'-tion) 1. A process of fossilization, in which an organic substance loses its volatile components and is pre-

served as a carbonaceous residue. 2. The removal of impurities from liquids by boiling. The steam is condensed to almost pure liquid; pollutants remain in the concentrated residue. This is the most common method of removing salts from sea water.

**distortional wave** (dis-tor'-tion-al) *S wave.*

**distributary** (dis-trib'-u-tar-y) An outflowing branch of a river, such as occurs characteristically on a delta. Ant: *tributary.*

**distributive province** (dis-trib'-u-tive) The environment embracing all rocks that contribute to the formation of a contemporaneous sedimentary deposit and the agents responsible for their distribution. Cf: *provenance.*

**disturbance** (dis-turb'-ance) A term used by some geologists for a minor orogeny, e.g. the *Pali-sades disturbance.* Cf: *event.*

**divergence** (di-ver'-gence) 1 The separation of ocean currents by horizontal flow in different directions from a common source, usually upwelling; also, the area in which this occurs. Cf: *convergence.* 2. *adaptive radiation.* 3. The decrease in amplitude of wave front because of geometrical spreading.

**divergent plate boundary** (di-ver'-gen') *accreting plate boundary.*

**diversion** (di-ver'-sion) 1. The process by which a stream effects changes in the course of another stream, as by aggradation or capture. 2. The artificial removal of water from a stream or lake into

a canal or other conduit. 3. A channel to divert water for purposes such as flood prevention or irrigation.

**diversity** (di-ver'-si-ty) The number of different kinds of organisms in an *assemblage.*

**diverted stream** (di-vert'-ed) A stream whose course or drainage has been affected by *piracy*; e.g. a captured stream.

**divide** (di-vide') 1. The line of separation or the narrow tract of high ground marking the boundary between two adjacent drainage basins, dividing the surface waters that flow in one direction from those that flow in the opposite direction. Cf: *continental divide.* 2. *ground-water divide.*

**diviner** (di-vin'-er) *dowser.*

**divining rod** (di-vin'-ing) A forked wooden stick or similar object, used in *dowsing.* It supposedly dips downward sharply when held over a body of ground water or a mineral deposit. Syn: *dowsing rod.*

**D layer** The seismic region of the earth between 1000 km and 2900 km, equivalent to the *lower mantle.* It is a part of a classification of the earth's interior made up of layers A to G.

**dodecahedron** (do-dec'-a-he'-dron) A crystal form with 12 faces that are either pentagonal or rhombic. Each face is parallel to one crystallographic axis and intersects the other two at equal distances. See also: *pyritohedron*; *rhombic dodecahedron.*

**dogtooth spar** A variety of calcite

in sharply pointed crystals of acute scalenohedral form resembling the teeth of a dog.

**dolarenite** (dol-ar'-e-nite) Dolomite rock consisting of sand-sized grains, a consolidated dolomitic sand.

**dolerite** (dol'-er-ite) In the U.S., a syn. of *diabase*. In British usage, *dolerite* is preferred to *diabase*.

**doleritic** (dol'-er-it'-ic) 1. Of or pertaining to *dolerite*. 2. A preferred syn. of *ophitic* in European usage.

**doline** (do'-li-ne [doe'-lee-nal]) A syn. of *sinkhole*. Etymol: Slovene *dolina*.

**dolocast** (do'-lo-cast) A cast or impression of a dolomite crystal, preserved in an insoluble residue. Adj: *dolocastic*. Cf: *dolomold*.

**doloclast** (do'-lo-clast) A fragment of dolomite derived by erosion from an older rock; also, an *intraclast* disrupted from partly consolidated dolomitic mud on the bottom of a sea or lake.

**dolomite** (do'-lo-mite) 1. A common rock-forming mineral,  $\text{CaMg}(\text{CO}_3)_2$ . Part of the magnesium may be replaced by ferrous iron. Dolomite is white to light-colored and has perfect rhombohedral cleavage. Cf: *calcite*. 2. A sedimentary rock, of which more than 50% by weight consists of the mineral dolomite; specif. a rock containing more than 90% mineral dolomite and less than 10% calcite. Most dolomite is associated and often interbedded with limestone. See also: *primary dolomite*; *magnesian limestone*. Syn. *dolostone*.

**dolomitic limestone** (do-lo-mit'-ic)

1. A limestone in which the mineral dolomite is conspicuous, but calcite is more abundant; specif. a limestone containing 10-50% dolomite and 50-90% calcite. Cf: *calcitic dolomite*; *magnesian limestone*. 2. A limestone that has been incompletely dolomitized.

**dolomitization** (do'-lo-mit'-i-za'-tion) The process by which limestone is wholly or partly converted to dolomite rock or dolomitic limestone by the replacement of the original calcium carbonate (calcite) by magnesium carbonate (mineral dolomite), usually through the action of magnesium-bearing water (sea water or percolating meteoric water).

**dolomold** (do'-lo-mold) A rhombohedral cavity of any size left in chert, pyrite, shale, or other material, by the solution of a dolomite (or calcite) crystal.

**dolomorph** (do-lo-mor'-phic) Said of an *insoluble residue* in which calcite or dolomite has been replaced by an insoluble mineral which fills the rhombohedral dolomold cavity in chert or other matrix.

**dolostone** (do'-lo-stone) A term proposed for the sedimentary rock *dolomite*, in order to avoid confusion with the mineral of the same name.

**domain** (do-main') The areal extent of a given lithology or environment; specif. the area in which a given set of physical controls combined to produce a distinctive *sedimentary facies*.

**dome** 1. An uplift or anticlinal structure, circular or elliptical in outline, in which the rocks dip gently away in all directions. A dome may be small, e.g. a Gulf Coast salt dome, or many kilometers across, as in the type structure, the Nashville Dome of Tennessee. 2. Any smoothly rounded landform or rock mass that roughly resembles the dome of a building, e.g. the rounded granite peaks of Yosemite, Calif. 3. A circular bulge, several kilometers wide and a few hundred meters high, in *mare* regions of the moon. 4. An open crystal form consisting of two nonparallel faces that intersect along and astride a symmetry plane. 5. *lava dome*. 6. *volcanic dome*.

**dome mountain** A mountain produced where flat-lying sedimentary rocks are warped or bowed upward to form a structural dome, a mountain resulting from dissection of such a dome. Example: the Black Hills of South Dakota.

**doodlebug** (doo'-dle-bug) 1 A popular term for any of various kinds of geophysical prospecting equipment. 2. Any of a large number of unscientific devices with which it is claimed minerals and oil deposits can be located

**dormant volcano** (dor'-mant) A volcano that is not now erupting but that has erupted within historic time and is considered likely to do so in the future. There is no precise distinction between a dormant and an *active volcano*.

**dorsal** (dor'-sal) 1. Pertaining to, or situated near or on, the back or upper surface of an animal or of its parts. 2. Referring to the direction or side of an echinoderm away from the mouth, normally downward and outward—Ant: *ventral*.

**dorsal exoskeleton** 1. The resistant mineralized dorsal covering or integument of a trilobite. 2. The commonly calcified part of the covering of a crustacean.—Less-preferred syn: *carapace*.

**dot chart** 1. A graphic aid used in correction of station gravity for terrain effect, or for computing gravity effects of irregular masses. It can be used also in magnetic interpretation. 2. A graphic transparent chart used in the calculation of the gravity effects of various structures; dots on the chart represent unit areas.

**double refraction** *birefringence*

**doubly plunging fold** (dou'-bly) A fold, either an anticline or a syncline, that reverses its direction of plunge within the observed area.

**downbuckle** (down'-buck-le) A compressional downfolding of silic crust, associated with oceanic trenches. Cf: *tectogene*.

**downdip block** The rocks on the *downthrown* side of a fault. Cf: *updip block*.

**downfaulted** Said of the rocks on the *downthrown* side of a fault, or the *downdip block*. Cf: *upfaulted*.

**downs** A rolling upland, generally treeless and suitable for grazing, e.g. the South Downs of south-eastern England, underlain by



chalk.

**dowthrow** 1. The downthrown side of a fault. 2. The amount of downward vertical displacement of a fault.—Cf: *upthrow*, *heave*.

**dowthrown** Said of that side of a fault that appears to have moved downward, compared with the other side. Cf: *upthrown*.

**dow-to-basin fault** A term used in petroleum geology for a fault whose downthrown side is toward the adjacent basin.

**dowward enrichment** *supergene enrichment*.

**dowwarping** Subsidence of a regional area of the earth's crust, as in an *orogenic belt* or a cratonic basin Cf: *upwarping*.

**dowwasting** 1. *mass wasting*. 2. The thinning of a glacier during ablation.

**dowser** (dows'-er) One who practices *dowsing*. Syn: *diviner*; *witch*.

**dowsing** (dows'-ing) The practice of locating ground water; mineral deposits, or other objects by means of a *divining rod* or a pendulum.

**dowsing rod** *divining rod*.

**drag** 1. The bending of strata on either side of a fault, caused by the friction of the moving blocks along the fault surface; also, the bends or distortions so formed. 2. Fragments of rock and ore torn from an orebody and contained in and along a fault zone. Syn: *drag ore*.

**drag fold** A minor fold, usually one of a series, formed in an incompetent bed lying between more

competent beds, produced by movement of the competent beds in opposite directions relative to one another. Drag folds may develop on the limbs of larger folds, and beneath *thrust sheets*. They are usually a centimeter to a few meters in size.

**drag mark** 1. A long groove or striation produced by current drag of an object across a soft sedimentary surface. 2. An impression or cast of such a mark on the under surface of the overlying bed. Cf: *groove cast*.

**drainage** (drain'-age) 1. The manner by which the waters of an area flow off in surface streams or subsurface conduits. 2. Natural and artificial means for effecting discharge of water, as by a system of surface and subsurface passages. 3. A collective term for all the water bodies by which a region is drained, a *drainage system*. 4. All the water features shown on a map.

**drainage basin** A region or area bounded by a *divide* and occupied by a drainage system; specif. the tract of country that contributes water to a particular stream channel or system of channels, or to a lake, reservoir, or other body of water. Cf: *river basin*. Syn: *watershed*; *hydrographic basin*.

**drainage density** Ratio of the total length of all streams within a drainage basin to the area of that basin. It is a measure of the *topographic texture* of the area.

**drainage divide** The boundary be-

tween adjacent drainage basins; a *divide*.

**drainage pattern** The configuration or arrangement in plan view of the stream courses in an area, e.g. *dendritic drainage pattern*. It is related to local geologic and geomorphic features and history. Syn: *drainage network*.

**drainage system** A surface stream, or a body of impounded surface water, together with all other such streams and water bodies that are tributary to it and by which a region is drained. An artificial drainage system includes also surface and subsurface conduits.

**drapè fold** 1. A *supratenuous fold*. 2. A fold produced in layered rocks by movement of an underlying brittle block at high angles to the layering; a product of *forced folding*. In this usage, the term excludes supratenuous folds.

**draw** 1. A small ravine or shallow gulch, usually dry but containing water after a rainfall. 2. A sag or depression leading from a valley to a gap between two hills.

**drawdown** 1. The lowering of the water level in a well as a result of withdrawal. 2. The difference between the height of the water table and that of the water in a well. 3. Reduction of the pressure head as a result of the withdrawal of water from a well. Cf: *cone of depression*. 4. The vertical distance by which the level of a reservoir is lowered by the withdrawal of water.

**draw works** The powered winch

used in *rotary drilling* for lifting and lowering the drill pipe. Also spelled: drawworks.

**dredging (dredg'-ing)** 1. The various processes by which large floating machines, or dredges, scoop up earth material at the bottom of a body of water, raise it to the surface, and discharge it into a pipeline or barge, or return it to the water body after removal of ore minerals. 2. An ocean-bottom sampler that scoops sediment and benthic organisms as it is dragged behind a moving ship.

**dreikanter (drei'-kan-ter (dry'-kan-ter))** 1. A ventifact of wind-worn stone, having three curved faces intersecting in three sharp edges, resembling a Brazil nut. 2. A term loosely applied as a syn. of *ventifact*. —Etymol: German *Dreikanter*, "one having three edges".

**drift** 1. A general term for all rock material transported by glaciers and deposited directly from the ice or through the agency of melt-water. It is generally applied to Pleistocene deposits in large regions that no longer contain glaciers. 2. A *drift current*; also, the speed of such a current, in knots or in nautical miles per day. 3. Detrital material moved and deposited by waves and currents, e.g. *littoral drift*, driftwood. 4. In geophysics, a gradual change in a reference reading that is supposed to remain constant, esp owing to instrumental fatigue. 5. *continental drift*. 6. A horizontal underground passage driven along a

vein.

**drift-barrier lake** (drift'-bar-ri-er)

A glacial lake formed upstream from a moraine that has blocked a valley or a drainage course. Cf: *morainal lake*.

**drift current** A broad, shallow movement of surface ocean waters under the influence of prevailing winds. Syn: *wind drift*.

**drift curve** A graph of a series of gravity values read at the same station at different times and plotted in terms of instrument reading versus time.

**drift glacier** A small mass of flowing ice in a mountain area nourished primarily with windblown snow from adjacent snowfields, slopes, or ridges. Syn: *snowdrift glacier*; *glacieret*.

**drift ice** 1. Floating ice, e.g. floe fragments or icebergs. 2. *pack ice*.

**drift map** A British term for a geological map representing the visible ground, including all surficial deposits and only those rock outcrops exposed at the surface.

**drift mine** A mine opened by a horizontal passage, or *drift*.

**drift sheet** A sheetlike body of glacial drift, deposited during a single glaciation (e.g., Cary drift sheet) or during a series of closely related glaciations (e.g., Wisconsin drift sheet).

**drift theory** The theory that coal originates from the accumulation of plant material that has been transported from its place of growth and deposited in another locality, where coalification occurs. Ant: *in-situ theory*.

**drill bit** Any device at the lower end of a *drill stem*, used as a cutting or boring tool in drilling a hole. Syn: *bit*; *rock bit*.

**driller's log** The brief, often vernacular notations, included as part of a driller's report, that describe the gross characteristics of the well cuttings noted by the drilling crew as a well is drilled. It is useful only if a detailed sample log is not available.

**drilling mud** A carefully formulated heavy suspension, usually in water but sometimes in oil, used in rotary drilling. It commonly consists of bentonitic clays, chemical additives, and weighting materials such as barite. It is pumped continuously down the drill pipe, out through openings in the drill bit, and back up in the annulus between the pipe and the walls of the hole to a surface pit where it is screened and reintroduced through the *mud pump*. The mud lubricates and cools the bit; carries the cuttings up from the bottom; and prevents blow-outs and cave-ins by plastering friable or porous formations and maintaining a hydrostatic pressure in the borehole offsetting pressures of fluids that may exist in the formation. Syn: *mud*; *drilling fluid*.

**drilling rig** A general term for the derrick, power supply, draw works, and other surface equipment necessary in rotary or cable-tool drilling. Syn: *rig*.

**drill stem** 1. A term used in rotary drilling for the *drill string*. 2. A

term used in cable-tool drilling for a solid shaft or cylindrical bar of steel or iron attached to the drill bit to give it weight.—Also spelled: *drillstem*.

**drill-stem test** A test of the productive capacity of an oil or gas reservoir when the well is uncased and still full of drilling mud. The testing tool is lowered into the hole attached to the drill pipe and is placed opposite the formation to be tested. Packers are set to shut off the weight of the drilling mud, and the tool is opened to permit the flow of any formation fluid into the chamber, where it can be measured. Abbrev: DST. Cf: *wire-line test*.

**drill string** 1. A term used in rotary drilling for the assemblage in a borehole of drill pipe, drill collars, *drill bit*, and *core barrel* (if in use), connected to and rotated by the drilling rig at the surface. Syn: *drill stem*. 2. A term used in cable-tool drilling for the assemblages in a borehole of cable, drill bit, drill stem, and other tools, connected to the drilling rig at the surface.—Syn: *string*.

**dripstone** A general term for calcite or other mineral deposits formed in caves by dripping water, including *stalactites* and *stalagmites*, and also usually including similar deposits formed by flowing water. See also: *flowstone*; *cave onyx*; *travertine*.

**driven well** (driv'-en) A shallow well, usually of small diameter (3-10 cm), constructed by driving a series of connected lengths of pipe

into unconsolidated material to a water-bearing stratum, without drilling, boring, or jetting.

**drive pipe** 1. A pipe which is driven or forced into a bored hole, to shut off water or prevent caving. 2. A thick type of casing fitted at its lower end with a sharp steel shoe, which is employed when difficulty is encountered in inserting the casing.

**drowned coast** A shoreline with long, narrow channels, suggesting that subsidence of the coast has transformed the lower portions of river valleys into tidal estuaries. Cf: *dismembered river system*.

**drowned river mouth** The lower end of a river that is widened or submerged by sea water invading the coast; an *estuary*. Example: Chesapeake Bay

**drowned valley** A valley that is partly submerged by the intrusion of a sea or lake. Syn: *submerged valley*.

**drumlin** (drum'-lin) 1. A low, smoothly rounded, elongate hill of compact glacial till, or rarely other kinds of drift, built under the margin of the ice and shaped by its flow, or carved out of an older moraine by readvancing ice; its longer axis is parallel to the direction of movement of the ice. It usually has a blunt nose pointing in the direction from which the ice approached, and a gentler slope tapering in the other direction. Height is 8-60 m, average 30 m; length is 400-2000 m, average 1500 m. 2. *rock drumlin*.

**druse** 1. An irregular cavity or

opening in a vein or rock, having its interior surface or walls encrusted with small projecting crystals, usually of the same minerals as those of the enclosing rock, and sometimes filled with water. Cf: *geode*; *vug*. 2. A mineral surface covered with small projecting crystals; specif. the coating of crystals lining a druse in a rock, such as sparry calcite filling pore spaces in a limestone.—Etymol: German. Adj: *drusy*.

**drusy** (dru'-sy) 1. Pertaining to a *druse*, or containing many druses. Cf: *miarolitic*. 2. Pertaining to an insoluble residue or encrustation, esp of quartz crystals; e.g. a "drusy oolith" covered with subhedral quartz.

**dry basin** An interior basin in a climate so arid that the drainage is negligible. It contains no perennial lake.

**dry-bone ore** An earthy, friable, honeycombed variety of smithsonite, usually found in veins or beds in stratified calcareous rocks, accompanying sulfides of zinc, iron, and lead. The term is sometimes applied to hemimorphite. Syn: *dry bone*.

**dry bulk density** The specific gravity of a substance, e.g. a sediment, without interstitial water.

**dry delta** 1. *alluvial fan*. 2. *alluvial cone*.

**dry hole** The universal term in the petroleum industry for an unsuccessful well, i.e. one that does not produce oil or gas in commercial quantities.

**dry ice** 1. Ice at a temperature be-

low the freezing point; specif. bare glacier ice with no standing water or slush. 2. Solidified carbon dioxide.

**dry lake** 1. A basin that formerly contained a lake. 2. A *playa*; a tract of salt-encrusted land in an arid or semiarid region, occasionally covered by an intermittent lake.

**dry permafrost** Loose, crumbly permafrost containing little or no ice or moisture.

**dry-snow avalanche** An avalanche composed of dry, loose or powdery snow that is set in motion by the wind and is sometimes drifted but not wind-packed; the driving-ahead of a column of compressed air creates a vacuum in its wake. It is the fastest-moving of the snow avalanches, capable of reaching a speed of 450 km/hr. Syn: *dry avalanche*; *powder avalanche*.

**dry valley** A valley with little or no running water; a streamless valley. It may be the result of stream capture, a climatic change, or a fall in the water table. Dry valleys are common in areas underlain by chalk and limestone; other examples include wind gaps and glacial overflow channels. Syn: *dead valley*.

**DSDP** *Deep Sea Drilling Project*.

**d-spacing** In diffraction of X-rays by a crystal, the distance or separation between the successive and identical parallel planes in the crystal lattice. It is expressed as *d* in the *Bragg equation*. Syn: *diffraction spacing*.

**DST** *drill-stem test.*

**DTA** *differential thermal analysis.*

**dubiofossil** (du'-bi-o-fos'-sil) A structure of undetermined or uncertain origin, possibly biogenic; a *problematic fossil*. Etymol: Latin *dubius*, "doubtful", + *fossil*.

**ductile** (duc'-tile) Said of a rock that is able to sustain, under a given set of conditions, 5-10% deformation before fracturing or faulting. Cf: *brittle*.

**ductility** (duc-til'-i-ty) Property of solid material that undergoes more or less plastic deformation before it ruptures. Cf: *brittleness*.

**dug well** A shallow, large-diameter well constructed by excavating with hand tools or power machinery instead of by drilling or driving, such as a well for individual domestic water supplies.

**dumortierite** (du-mor'-ti-er-ite) A blue mineral of the sillimanite group,  $Al_7(BO_3)(SiO_4)_3O_3$ . It may contain iron, and it occurs principally in schists and gneisses.

**dumpy level** A leveling instrument in which the telescope is permanently attached to the leveling base and is capable only of rotation in a horizontal plane. Cf: *wye level*.

**dune** 1. A mound, ridge, or hill of wind-blown sand, either bare or covered with vegetation. Syn: *sand dune*. 2. A sand wave formed on a stream bed, transverse to the direction of flow and traveling downstream by erosion of sand from the gentle upstream slope and deposition on the steep downstream slope. It is similar to

an eolian dune but formed in moving water.

**dune complex** An aggregate of moving and fixed sand dunes in a given area, together with sand plains and the ponds, lakes, and swamps produced by the blocking of streams by the sand.

**dune lake** 1. A lake occupying a basin formed as a result of the blocking of the mouth of a stream by sand dunes migrating along the shore; e.g. Moses Lake, Wash. 2. A lake occupying a *deflation basin* among dunes.

**dune ridge** A series of parallel *fore-dunes* built along the shore of a retreating sea.

**durite** (dun'-ite) *Peridotite* consisting essentially of olivine, with accessory pyroxene, plagioclase, or chromite.

**durability index** (du-ra-bil'-i-ty) The relative resistance to abrasion exhibited by a sedimentary particle in the course of transportation.

**durain** (du'-rain) An ingredient of banded coal with dull luster, grey to brownish black color, and granular fracture. It occurs in bands up to many centimeters in thickness. Cf: *vitrain*; *clarain*; *fusain*. Syn: *attritus*.

**duration** (du-ra'-tion) 1. The interval of time in which a tidal current is either ebbing or flooding, reckoned from the middle of slack water. 2. The interval of time from high water to low water (falling tide), or from low water to high water (rising tide).

**duricrust** (du'-ri-crust) A general

term for a hard crust on the surface, or a layer in the upper horizons, of a soil in a semiarid climate. It is formed by the accumulation of soluble minerals deposited by mineral-bearing waters that move upward by capillary action and evaporate during the dry season. See also: *silcrete*; *calcrete*; *caliche* Cf: *hardpan*.

**duripan** (du'-ri-pan) A horizon in a soil characterized by cementation by silica. Duripans occur mainly in areas of volcanism that have arid or Mediterranean climates

**dust** 1. Dry solid matter of clay and silt size, which is readily blown about by the wind and may be carried considerable distances.

2. *cosmic dust* 3. *volcanic ash* 4. *gold dust*

**dust hole** A small *dust well*.

**dust tuff** An indurated deposit of fine volcanic *ash*. Essentially, a fine-grained tuff.

**dust well** A pit in glacier ice or sea ice produced when a patch of dark windblown particles on the ice surface are heated by sunlight and sink down into the ice. Cf: *dust hole*.

**dwarf fauna** A fossil assemblage consisting of specimens of small size. Many dwarf faunas result from sedimentary sorting, others from pathologies or environmentally influenced growth patterns. Syn: *depauperate fauna*; *impoverished fauna*.

**dynamic geology** (dy-nam'-ic) A general term for the branch of

geology that deals with the causes and processes of geologic phenomena; physical geology.

**dynamic metamorphism** The total of the processes and effects of orogenic movements and differential stresses in producing new rocks from old, with marked structural and mineralogical changes due to crushing and shearing at low temperatures and extensive recrystallization at higher temperatures. It may be regional in character. Cf: *dynamothermal metamorphism*; *regional metamorphism*. Syn: *dynamometamorphism*.

**dynamometamorphism** (dy'-na-mo-met'-a-mor'-phism) *dynamic metamorphism*.

**dynamothermal metamorphism** (dy'-na-mo-ther'-mal) A common type of metamorphism involving the effects of directed pressures and shearing stress as well as a wide range of confining pressures and temperatures. It is related to large orogenic belts, and hence is regional in character. Cf: *regional metamorphism*, *dynamic metamorphism*.

**dystrophic lake** (dys-troph'-ic) A lake that is characterized by a deficiency in nutrient matter and by a notably high oxygen consumption in the bottom layers; its water is brownish or yellowish with much unhumified or dissolved humic matter and it has a small bottom fauna. It is often associated with acidic peat bogs. Cf: *oligotrophic lake*; *eutrophic lake*.

# E

**early** Occurring near the beginning of a segment of time. The adjective is applied to the name of an era, period, or epoch to indicate relative time designation, and corresponds to *lower* as applied to the name of the equivalent time-stratigraphic unit, e.g. rocks of a Lower Jurassic batholith were intruded in Early Jurassic time. The initial letter is capitalized to indicate a formal subdivision (e.g. "Early Devonian") and is lower-cased to indicate an informal subdivision (e.g. "early Miocene"). Cf: *middle*; *late*.

**earth** That planet of the solar system which is third in order of distance from the sun, and fifth in size of the 9 major planets. Earth's equatorial radius is 6378 km (3963.5 mi); polar radius 6357 km (3941 mi); equatorial circumference 40,075 km (24,902 mi). 2. In engineering, material that can be moved and handled with a power shovel, scraper, or end loader. 3. An organic deposit that has remained unconsolidated, e.g. *diatomaceous earth*. 4. *fuller's earth*. 5. A difficultly reducible metallic oxide, such as alumina. See also: *rare earths*.

**earth current** Static or alternating electric current flowing through the ground and arising either in natural or artificial electric or magnetic fields. Syn: *ground current*; *telluric current*.

**earth curvature** The divergence of

the surface of the earth from a horizontal plane tangent at the point of observation. See also: *curvature correction*.

**earthflow** A mass-movement process and landform characterized by downslope sliding of soil and weathered rock over a discrete basal shear surface within well-defined lateral boundaries. Earthflows terminate in lobelike forms. They grade into mudflows through a continuous range in morphology associated with increasing fluidity. Also spelled: *earth flow*.

**earth hummock** A low, dome-shaped *frost mound*, consisting of an earthen core covered by a tight mass of vegetation, esp. mosses, and produced by hydrostatic pressure of ground water or by heaving from growth of ice lenses in arctic and alpine regions; the general height is 10-20 cm and the diameter ranges from 1/2 to 1 m. Earth hummocks form in groups to produce a nonsorted *patterned ground*.

**earthquake** A sudden motion or trembling in the earth caused by the abrupt release of slowly accumulated strain. Partial syn: *seismic event*. Syn: *quake*; *seism*; *temblor*.

**earthquake engineering** The study of the behavior of foundations and structures relative to seismic ground motion, and the attempt to mitigate the effect of earthquakes on such structures. Syn: *engineering seismology*.

**earthquake intensity** A measure of



the effects of an earthquake at a particular place. Intensity depends not only on the *earthquake magnitude*, but also on the distance from earthquake to epicenter and on the local geology. See also: *intensity scale*; *Mercalli scale*.

**earthquake magnitude** A measure of the strength of an earthquake, or the strain energy released, as determined by seismographic observations. See also: *Richter scale*. Cf: *earthquake intensity*.

**earthquake swarm** A series of minor earthquakes, none of which may be identified as the main shock, occurring in a limited area and time.

**earthquake wave** *seismic wave*.

**earthquake zone** An area of the earth's crust in which fault movements and sometimes associated volcanism occur; a *seismic area*. See also: *seismic belt*.

**earth science** An all-embracing term for sciences related to the earth (analogous, in educational parlance, to "life science"). It is occasionally used as a syn. for geology or geological sciences, but this usage is misleading because in its wider scope earth science may be considered to include such subjects as meteorology, physical oceanography, soil chemistry, and agronomy. The term is generally used in the singular.

**earth tide** The rising and falling of the surface of the solid earth in response to the same forces that produce the tides of the sea.

**Semidaily earth tides** fluctuate between 7 and 15 centimeters.

**earth tremor** A slight earthquake.

**earthy** 1. Composed of or resembling earth, or having the properties or nature of earth or soil, e.g. an earthy limestone. 2. Said of minerals having a dull luster and a surface rough to the touch. 3. Said of a type of fracture similar to that of a hard clay.

**ebb current** Water movement associated with the decrease in the height of a tide, generally seaward or down a tidal river or estuary. Cf: *flood current*.

**ebb tide** That part of a tide cycle between high water and the following low water, characterized by seaward or receding movement of water. Syn: *falling tide*. Ant: *flood tide*.

**echinoderm** (e-chi'-no-derm [e-ky'-no-derm]) Any solitary marine benthic (rarely pelagic) invertebrate, belonging to the phylum Echinodermata, characterized by radial symmetry, an endoskeleton formed of plates or ossicles of crystalline calcite, and a water-vascular system. Echinoids, asteroids, and crinoids belong in this phylum.

**echinoid** (ech'-i-noid [ek'-i-noid]) A class of free-moving *echinoderms*, mostly with rigidly plated bodies of spherical or disk-like form, e.g. sea urchin or sand dollar.

**echogram** (ech'-o-gram) The graphic record made by an *echo sounder*, in the form of a continuous profile. See also: *fathogram*.

**echo sounder** A survey instrument that determines depth of water by measuring the time required for a sound signal to travel to the bottom and return. See also: *echo-gram*; *fathometer*; *precision depth recorder*.

**Eckert projection** (Eck'-ert) One of a series of six map projections of the entire earth, on which the poles are represented as straight lines 1/2 the length of the equator. The parallels are rectilinear, and the meridians may be rectilinear or curved.

**eclogite** (ec'-lo-gite) A granular rock composed essentially of garnet (almandine-pyroxene) and sodic pyroxene (omphacite). Rutile, kyanite, and quartz are typically present.

**eclogite facies** The set of metamorphic mineral assemblages (facies) in which basic rocks are represented by omphacitic pyroxene and almandine-pyroxene garnet. Also common, although not essential, is the association pyroxene + olivine + diopside + enstatite. Phase-equilibrium work has shown that these high-density mineral associations indicate a high pressure of crystallization.

**ecologic facies** (ec-o-log'-ic) *environmental facies*.

**ecology** (e-col'-o-gy) The study of the relationships between organisms and their environment. See also: *paleoecology*. Adj: *ecologic*; *ecological*. Syn: *bionomics*.

**economic geology** (e-co-nom'-ic) The study and analysis of geological bodies and materials that can

be utilized profitably by man, including fuels, metals, nonmetallic minerals, and water; the application of geologic knowledge and theory to the search for and the understanding of mineral deposits.

**ecosphere** (ec'-o-sphere) Portions of the universe favorable for the existence of living organisms; esp. the *biosphere*.

**ecosystem** (ec'-o-sys-tem) An ecological system, composed of organisms and their environment. It is the result of interaction between biological, geochemical, and geophysical systems.

**ecotope** (ec'-o-tope) The habitat of a particular organism. See also: *biotope*.

**écoulement** (é-coule'-ment) *gravitational sliding*.

**eddy** A circular current of water running contrary to the main current; a small *whirlpool*.

**edge water** The water around the margins of an *oil pool* or a *gas pool*. Also spelled: *edgewater*.

**edgewise conglomerate** A conglomerate consisting of small flat pieces of rock, usually calcareous, packed so as to lie steeply inclined to the bedding.

**effective diameter** (ef-fec'-tive) 1. The diameter of the particles in an assumed rock or soil that would transmit water at the same rate as a rock or soil under consideration, and that is composed of spherical particles of equal size arranged in a specified manner. 2. The approximate diameter of a rock or soil particle equal to the sieve size

that allows 10% (by weight) of the material to pass through; the particle diameter of the 90-percent line of a cumulative curve.—Syn: *effective size*.

**effective permeability** The ability of a rock to conduct one fluid, e.g. gas, in the presence of other fluids, e.g. oil or water. See also: *absolute permeability*; *relative permeability*.

**effective porosity** The percent of the total volume of a given mass of soil or rock that consists of interconnecting voids. Cf: *porosity*.

**effective size** *effective diameter*.

**effective stress** The average normal force per unit area transmitted directly from particle to particle of a soil or rock mass. It is the stress that is effective in mobilizing internal friction. It attains a maximum value at complete consolidation and before shear failure. Syn: *effective pressure*; *intergranular pressure*.

**efflorescence** (ef-flō-res'-cence) 1. A white powder, produced on the surface of a rock or soil in an arid region by evaporation of water, or by loss of water of crystallization on exposure to the air. It commonly consists of soluble salts such as gypsum, calcite, natron, or halite. 2. The process by which an efflorescent salt or crust is formed.

**effluent** (ef-flu-ent) adj. Flowing forth or out; emanating.—n. 1. A surface stream that flows out of a lake (e.g. an outlet), or a stream or branch that flows out of a larger stream (e.g. a distributary). Ant:

*influent*. Cf: *effluent stream*. 2. A liquid discharged as waste, such as contaminated water from a factory or the outflow from a sewage works; water discharged from a storm sewer or from land after irrigation.

**effluent stream** 1. A stream that receives water from the zone of saturation; its channel lies below the water table. 2. *effluent*.

**effusion** (ef-fu'-sion) The emission of relatively fluid lava onto the earth's surface; also, the rock so formed. Cf: *extrusion*.

**effusive** (ef-fu'-sive) *extrusive*.

**einkanter** (ein'-kan-ter) A *ventifact* having only one wind-cut face or a single sharp edge; it implies a steady, unchanging wind direction.

**ejecta** (e-jec'-ta) 1. Material thrown out by a volcano; *pyroclastics*. Syn: *ejectamenta*. 2. Glass, rock fragments, and other material thrown out of an explosion or impact crater during formation.

**elastic** ('-las'-tic) Said of a body in which strains are instantly and totally recoverable and in which deformation is independent of time. Cf: *plastic*.

**elastic aftereffect** *creep recovery*.

**elastic bitumen** *elaterite*.

**elastic constant** One of various coefficients that define the elastic properties of matter, e.g. *Poisson's ratio*.

**elastic deformation** A nonpermanent deformation, which disappears when the stress is released. Commonly, that deformation in

which stress and strain are linearly related, in accordance with *Hooke's law*.

**elastic discontinuity** A boundary between strata of different elastic moduli and/or density, at which seismic waves are reflected and refracted.

**elasticity** (e-las-tic'-i-ty) The property or quality of being elastic.

**elastic limit** The maximum stress that a material can withstand without undergoing permanent deformation. Syn: *yield point*.

**elasticoviscous** (e-las'-ti-co-vis'-cous) Said of a material in which instantaneous elastic strain at a constant stress is followed by continuously developed permanent strain so long as the stress is maintained.

**elastic rebound** Elastic recovery from strain.

**elastic-rebound theory** The statement that movement along a fault is the result of abrupt release of a progressively increasing elastic strain between the rock masses on either side of the fault. Such a movement returns the rocks to a condition of little or no strain.

**elaterite** (e-lat'-er-ite) A brown asphaltic pyrobitumen, soft and elastic when fresh but hard and brittle on exposure to air. It is derived from the metamorphism of petroleum. Syn: *elastic bitumen*.

**E layer** The seismic region of the earth from 2900 km to 4710 km, equivalent to the *outer core*. It is a part of a classification of the earth's interior made up of layers

A to G.

**electrical resistivity** The electrical resistance per unit length of a unit cross-sectional area of a material.

**electric log** (e-lec'-tric) The generic term for a *well log* that displays electrical measurements of induced current flow (*resistivity log*; *induction log*) and natural potential (*spontaneous-potential curve*) in the rocks of an uncased borehole. Abbrev: E-log. Informal syn: *resistivity log*.

**electrodialysis** (e-lec'-tro-di-al'-y-sis) *Dialysis* assisted by the application of an electric potential across the semipermeable membrane. An important use of electrodialysis is in water desalination. Cf: *electro-osmosis*.

**electrolysis** (e-lec'-trol'-y-sis) A method of breaking down a compound in its natural form or in solution by passing an electric current through it, the ions present moving to one electrode or the other where they may be released as new substances.

**electromagnetic prospecting** (e-lec'-tro-mag-net'-ic) A geophysical method employing the generation of electromagnetic waves at the earth's surface; when the waves impinge on a conducting formation or ore body at depth they induce currents that are the source of new waves radiated from the conductors and detected by instruments at the surface.

**electron capture** (e-lec'-tron) A type of radioactive transformation in which an electron from one of the inner shells of an atom

is captured by the nucleus.

**electron diffraction pattern** The interference pattern seen when a beam of electrons is sent through a substance, each substance having a characteristic pattern. Electron diffraction patterns contain basic crystallographic information as well as information about orientation, defects, crystal size, and additional phases. See also: *X-ray diffraction pattern*.

**electron microprobe** An analytical instrument that uses a finely focused beam of electrons to excite X-ray emission from selected portions of a sample. The composition of the sample at the point of excitation can be determined by analysis of the emitted X-ray spectrum.

**electron microscope** An electron-optical instrument in which a beam of electrons, focused by systems of electrical or magnetic lenses, is used to produce enlarged images of minute objects on a fluorescent screen or photographic plate in a manner similar to that in which a beam of light is used in a compound microscope. The electron microscope, because of the very short wavelength of the electrons, is capable of resolving much finer structures than the optical instrument, with magnifications on the order of 100,000X. See also: *scanning electron microscope*.

**electro-osmosis** The motion of liquid through a membrane under the influence of an applied electric field. See also: *osmosis*. Cf: *elec-*

*tro-dialysis*.

**electrostatic precipitator** (e-lec'-tro-stat'-ic) An air-pollution-control device that removes particulate matter from smoke or gas by imparting an electrical charge to particles for collection on an electrode.

**electroviscosity** (e-lec'-tro-vis-cos'-i-ty) The viscosity of a fluid as influenced by electric properties, e.g. greater viscosity of a low-conductivity fluid than of a high-conductivity fluid flowing through narrow capillaries.

**electrum** (e-lec'-trum) A natural alloy of gold and silver (Au,Ag), ranging from pale to deep yellow. See also: *gold*.

**element** (el'-e-ment) A substance that cannot be decomposed into other substances except by radioactive decay.

**elevation** (el-e-va'-tion) 1. The vertical distance from mean sea level to a point or object on the earth's surface, *height* above sea level. In modern surveying practice, "elevation" indicates heights on the earth, whereas *altitude* indicates heights of points in space above the earth's surface. 2. A general term for a topographically elevated feature.

**elevation correction** 1. The correction applied to time values observed in reflection or refraction seismic surveys due to difference of station elevation, in order to reduce the observations to an arbitrary reference datum. 2. The corrections applied to observed gravity values because of differ-

ences of station elevation, to reduce them to any arbitrary reference or datum level, usually sea level. The free-air correction takes care of the vertical decrease of gravity with increase of elevation, and the Bouguer correction takes care of the attraction of the material between the reference datum and that of the station.

**ellipsoidal lava** (el-lip-soid'-al) An inclusive term for any lava flow that has an ellipsoidal structure, esp. *pillow lava*.

**elutriation** (e-lu-tri-a'-tion) 1 A method of mechanical analysis of a sediment, in which the finer, lightweight particles are separated from the coarser, heavy particles by means of a slowly rising current of air or water of known and controlled velocity carrying the lighter particles upward and allowing the heavier ones to sink. 2 Purification, or removal of material from a mixture or in suspension in water, by washing and decanting, leaving the heavier particles behind.

**eluvial** (e lu'-vi-al) 1 Pertaining to eluvium. *residual*. 2 Pertaining to or composed of wind-deposited eluvium, e.g. in the passive phase of a dune cycle in which vegetation checks deflation. Cf. *eolian*. 3 Said of an incoherent ore deposit, resulting from rock decomposition or disintegration in place. It may have slumped or washed downslope but has not been transported by a stream.

**eluviation** (e-lu-vi-a'-tion) The downward movement of soluble

or suspended material in a soil, from the A horizon to the B horizon, by ground-water percolation. The term refers especially but not exclusively to the movement of colloids, whereas the term *leaching* refers to the complete removal of soluble materials. Adj. *eluvial*, *eluviated*. Cf. *illuviation*.

**eluvium** (e lu vi-um) 1 An accumulation of rock debris produced in place by the decomposition or disintegration of rock, a weathering product or residue. 2 Fine soil or sand moved and deposited by the wind. Cf. *alluvium*.

**emanation** (em-a-na-tion) The escape of steam and other gases from a lava or volcano, or of gases and hydrothermal fluids from a magma. See also *mineralizer*.

**embankment** 1 A sand bar barrier or spit built out from the shore of a sea or lake by waves and currents depositing excess material at its deep end; it may be above or below water. Syn. *bank*. 2 A dike, seawall, or other linear structure of earth material built to retain water or tailings, or to carry a roadway or railroad.

**embayed** (em-bayed) Formed into a bay or bays as an embayed shore.

**embayment** 1 The formation of a bay along a coast; also the bay itself. 2 The penetration of a crystal by another, esp. of phenocrysts by microcrystalline groundmass material. 3 The corrosion of a crystal or foreign in-

clusion by the magma in which it occurs. 4. A downwarped region of stratified rocks that extends into a region of other rocks, e.g. the Mississippi Embayment of the U.S. Gulf Coast.

**embouchure** (em-bou-chure' [em-booshure']) The mouth of a river, or that part where it enters the sea.

**emerald** (em'-er-ald) A brilliant green variety of beryl, highly prized as a gemstone and birthstone for May. The color is caused by the presence of chromium or possibly vanadium.

**emergence** (e-mer'-gence) 1. A change in the levels of water and land such that areas formerly under water are exposed; it results from uplift of the land or fall of the water level. Ant: *submergence*. 2. The place where an underground stream appears at the surface to become a surface stream. Syn: *resurgence*; *rise*.

**emery** (em'-er-y) 1. A gray to black granular impure variety of *corundum*, which contains magnetite or hematite. It occurs as masses in limestone and as segregations in igneous rocks. It is used in granular form for polishing and grinding. 2. *emery rock*.

**emery rock** A granular rock that is composed essentially of an impure mixture of corundum, magnetite, and spinel, and that may be formed by magmatic segregation or by metamorphism of highly aluminous sediments. Syn: *emery*; *corundolite*.

**emplacement** (em-place'-ment) 1.

The process of *intrusion* of igneous rocks. 2. The localization of ore minerals by any process; ore deposition.

**emulsion** (e-mul'-sion) A colloidal dispersion of one liquid in another.

**enantiomorphous** (en-an'-ti-o-mor'-phous) Said of two crystals that are mirror images of each other, e.g. right-handed and left-handed quartz.

**enantiotropy** (en-an'-ti-ot'-ro-py) The relationship between crystal *polymorphs* that possess a stable transition point and that therefore can be stably interconverted by changes of temperature and/or pressure. Cf: *monotropy*.

**enargite** (en-ar'-gite) A grayish-black or iron-black orthorhombic mineral:  $\text{Cu}_3\text{AsS}_4$ . It is an important ore of copper.

**encroachment** (en-croach'-ment) The advance of water that replaces oil or gas withdrawn from a reservoir.

**encrustation** (en-crus-ta'-tion) 1. A coating of minerals formed on a rock surface, e.g. calcite on cave objects. 2. A thin sheetlike organic growth, esp. a colonial invertebrate such as a bryozoan or coral, closely adhering to the substrate and mirroring its irregularities. 3. The process by which a crust or coating is formed.—Also spelled: *incrustation*.

**endellite** (en-dell'-ite) A name used in the U.S. for a clay mineral:  $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 \cdot 4\text{H}_2\text{O}$ . It is the more hydrous form of halloysite, and is synonymous with *halloyette* of

European authors.

**endemic** (en-dem'-ic) Native, or confined naturally to a particular area or region; indigenous.

**end member** 1. One of the two or more simple compounds of which an isomorphous (solid-solution) series is composed. 2. One of the two extremes of a series, e.g. types of sedimentary rock or of fossils.

**end moraine** A ridgelike accumulation of *till* that marks a stillstand position of a present or past glacier front. Cf: *terminal moraine*.

**endogene effect** (en'-do-gene) The contact-metamorphic effect of igneous intrusion on the margin of the intrusive body itself. Cf: *exogene effect*.

**endogenetic** (en'-do-ge-net'-ic) A term applied to processes that originate within the earth, and to rocks, ore deposits, and landforms that owe their origin to such processes. Cf: *exogenetic*. Syn: *endogenic*; *endogenous*.

**endogenous** (en-dog'-e-nous) *endogenetic*.

**endomorphism** (en-do-mor'-phism) Changes within an igneous rock produced by the complete or partial assimilation of country-rock fragments or by reaction with the country rock. It is a form of *contact metamorphism*, with emphasis on changes produced within the igneous body rather than in the country rock. Cf: *exomorphism*. Partial syn: *endogene effects*. Syn: *endometamorphism*.

**endoskeleton** (en-do-skel'-e-ton) The internal skeleton or support-

ing framework of an animal. Cf: *exoskeleton*.

**endothermic** (en-do-ther'-mic) Pertaining to a chemical reaction that occurs with an absorption of heat. Ant: *exothermic*.

**end product** A stable *daughter element* resulting from radioactive decay.

**endurance limit** That stress below which a material can withstand hundreds of millions of repetitions of stress without fracturing. Syn: *fatigue limit*.

**en echelon** (en ech'-e-lon [on esh'-e-lon]) adj. Said of geologic features that are in an overlapping or staggered arrangement, e.g. faults. Each is relatively short but collectively they form a linear zone, in which the strike of the individual features is oblique to that of the zone as a whole. Etymol: French *en échelon*, "in step-like arrangement".

**energy level** (en'-er-gy) The kinetic energy (due to wave or current action) that existed or exists in the water of a sedimentary environment, either at the interface of deposition or a meter or two above it. See also: *high-energy environment*; *low-energy environment*.

**engineering geology** (en-gi-neer'-ing) Application of the geological sciences to engineering practice, to assure that the geologic factors affecting the location, design, and construction of engineering works are recognized and adequately provided for. Syn: *geological engineering*.



**englacial** (en-gla'-cial) Contained, embedded, or carried within the body of a glacier or ice sheet; said of meltwater streams, till, drift, moraine, etc. Syn: *intraglacial*.

**englacial drift** Rock material contained within a glacier or ice sheet.

**enrichment supergene enrichment**

**enstatite** (en'-sta-tite) A common rock-forming mineral of the orthopyroxene group,  $MgSiO_3$ . It is isomorphous with hypersthene. Enstatite is an important primary constituent of intermediate and basic igneous rocks. Cf: *bronzite*.

**enterolithic** (en'-ter-o-lith'-ic) 1. Said of a sedimentary structure consisting of small intestine-like folds that originate through chemical changes involving an increase in the volume of the rock; e.g. said of local crumpling formed in an evaporite by the swelling of anhydrite during hydration to gypsum. 2. Said of the deformation or folding that produces enterolithic structures.

**enthalpy** (en'-thal-py) A thermodynamic quantity that is defined as the sum of a body's internal energy plus the product of its volume multiplied by the pressure. Syn: *heat content*.

**Entisol** (En'-ti-sol) In U.S. Dept. of Agriculture soil taxonomy, a soil order characterized by dominance of mineral soil materials and absence of distinct horizons. Cf: *azonal soil*.

**entrainment** The process of picking up and carrying along, as the collecting and movement of sedi-

ment by currents, or the incorporation of air bubbles into a cement slurry.

**entrenched meander** 1. An *incised meander* carved downward into the surface of the valley in which it originally formed; it exhibits a symmetrical cross profile. Such a form suggests rejuvenation of a meandering stream, as from rapid vertical uplift or a lowering of base level. Cf: *ingrown meander*. 2. A generic term used as a syn. of *incised meander*. Also spelled: *intrenched meander*.

**entrenched stream** A stream, often meandering, that flows in a narrow trench or valley cut into a plain or relatively level upland; e.g. a stream that has inherited its course from a previous cycle of erosion and that cuts into bedrock with little modification of the original course. Also spelled: *intrenched stream*.

**entropy** (en'-tro-py) 1. A measure of the energy in a system that cannot be converted into another form of energy. 2. A measure of the degree of mixing of different kinds of rock in a stratigraphic unit; as the composition approaches that of a single component, the entropy approaches zero. 3. The probability of a given distribution of energy utilization within or along a stream, the most probable condition existing when the stream is graded or the energy is as uniformly distributed as permitted by physical constraints.

**entry** (en'-try) A more or less horizontal entrance to a mine, or an

underground passage used as a haulage road or manway, or for ventilation. Syn: *portal*.

**entry pressure** *displacement pressure*.

**envelope** (en'-ve-lope) The outer or covering part of a fold, especially of a folded structure that includes some sort of structural break. Cf: *core*.

**environmental facies** (en-vi'-ron-men'-tal) Sedimentary aspects or characteristics that are controlled entirely by the nature of the environment. These are not three-dimensional bodies of rock or sediments, but areas inferred from the results of a combination of mutually interacting conditions exhibited as distinctive sedimentary types and biologic communities. See also: *facies*. Syn: *ecologic facies*.

**environmental geochemistry** The effect on man of the distribution and interrelations of the chemical elements and radioactivity among surficial rocks, water, air, and biota.

**environmental geology** The application of geologic principles and knowledge to problems created by man's occupancy and exploitation of the physical environment. See also: *urban geology*.

**environmental impact statement** A document prepared by industry or a political entity on the environmental impact of its proposals for legislation and other major actions significantly affecting the quality of the human environment. **Environmental impact**

statements are used as tools for decision making and are required by the National Environmental Policy Act.

**Eocene** (E'-o-cene) An epoch of the early Tertiary period, after the Paleocene and before the Oligocene; also, the corresponding worldwide series of rocks. It is sometimes considered to be a period, when the Tertiary is designated as an era.

**Eocene** (E'-o-gene) *Paleogene*.

**aeolian** (e-o'-li-an) 1 Pertaining to the wind; esp. said of such deposits as loess and dune sand, of sedimentary structures such as wind-formed ripple marks, or of erosion and deposition accomplished by the wind. 2. Said of the active phase of a dune cycle, marked by diminished vegetal control and increased dune growth. Cf: *eluvial*. —Syn: *aeolian*.

**colith** (e'-o-lith) The most primitive type of man-made stone implements.

**cometamorphism** (e'-o-met'-a-mor'-phism) Early metamorphism, or the very beginnings of metamorphism, esp. as affecting hydrocarbons, which are highly vulnerable.

**eon** (e'-on) 1. Any grand division or large part of geologic time, specif. the longest time unit, next in order of magnitude above *era*, e.g. the Phanerozoic Eon, which includes the Paleozoic, Mesozoic, and Cenozoic eras. 2. One billion ( $10^9$ ) years.

**Eötös effect** (Eö'-vös) The centripetal acceleration caused by

east-west velocity over the surface of the rotating earth. It must be corrected for in making gravity measurements.

**Eötvös torsion balance** *torsion balance*.

**Eötvös unit** A unit of gravitational gradient or curvature;  $10^{-6}$  mgal/cm.

**epeiric sea** (e-peí'-ric [e-pi'-ric]) *epicontinental sea*.

**epeirogenesis** (e-peí'-ro-gen'-e-sis) *epeirogeny*.

**epeirogenic movement** (e-peí'-ro-gen'-ic) *epeirogeny*.

**epeirogeny** (ep-ci-rog'-e-ny) Movements of uplift and subsidence that have produced the broader features of the continents and oceans, e.g. plateaus and basins, in contrast to *orogeny*, which has produced mountain chains. Movements in epeirogeny are dominantly vertical. Adj: *epeirogenic*. See also: *diastrophism*. Syn: *epeirogenesis*.

**ephemeral stream** (e-phem'-er-al) A stream or portion of a stream which flows briefly in direct response to precipitation in the immediate vicinity, and whose channel is at all times above the water table Cf: *intermittent stream*.

**epi-** A prefix signifying "on" or "upon".

**epibole** (ep'-i-bole) *acme-zone*.

**epicenter** (ep'-i-cen-ter) The point on the earth's surface directly above the *focus* of an earthquake.

**epiclastic** (ep-i-clas'-tic) Said of mechanically deposited sediments (gravel, sand, mud) consisting of weathered products of older

rocks. Cf: *autoclastic*.

**epicontinental** (ep'-i-con'-ti-nen'-tal) Situated on the continental shelf or on the continental interior, as an epicontinental sea. Cf: *mediterranean*.

**epicontinental sea** A sea on the continental shelf or within a continent. Syn: *inland sea*; *epeiric sea*.

**epidote** (ep'-i-dote) A green monoclinic mineral,  $\text{Ca}_2(\text{Al,Fe})_3\text{Si}_3\text{O}_{12}(\text{OH})$ . It is common in low-grade metamorphic rocks derived from limestone.

**epieugeosyncline** (ep'-i-eu'-ge-o-syn'-cline) A deeply subsiding trough with limited volcanism, associated with rather narrow uplifts and overlying a deformed and intruded *eugeosyncline*. Syn: *backdeep*.

**epigene** (ep'-i-gene) 1 Said of a geologic process, or of its resultant features, occurring at or near the earth's surface Cf: *hypogene*. Syn: *epigenic*. 2. Pertaining to a crystal that is not natural to its enclosing material, e.g. a *pseudomorph*.

**epigenesis** (ep-i-gen'-e-sis) 1. Change in the mineral character of a rock as a result of external influences acting at or near the earth's surface; e.g., mineral replacement during metamorphism. 2. The changes at low temperatures and pressures that affect sedimentary rocks after their compaction, exclusive of weathering and metamorphism; e.g. dolomitization after deposition. The term is equivalent to late

*diagenesis*

**epigenetic** (ep'-i-ge-net'-ic) 1. Said of a mineral deposit of origin later than that of the enclosing rocks. 2. Said of a sedimentary mineral, texture, or structure formed after deposition of the sediment.—Cf: *syngenetic*.

**epilimnion** (ep-i-lim'-ni-on) The uppermost layer of water in a lake, characterized by an essentially uniform temperature that is generally warmer than elsewhere in the lake and by a relatively uniform mixing caused by wind and wave action; specif. the light (less dense), oxygen-rich layer of water that overlies the *metalimnion* in a thermally stratified lake. The oceanographic equivalent is *mixed layer*. Cf: *hypolimnion*.

**epinorm** (ep'-i-norm) Theoretical calculation of minerals in metamorphic rocks of the *epizone*, as indicated by chemical analyses. Cf: *catanorm*; *mesonorm*.

**epipelagic** (ep'-i-pe-lag'-ic) Pertaining to the *pelagic* environment of the ocean to a depth of 100 fathoms. Cf: *mesopelagic*.

**epiplankton** (ep-i-plank'-ton) Organisms that are attached to floating vegetation or to mobile swimmers, esp. to vertebrates like turtles, sea snakes, and porpoises. Syn: *pseudoplankton*.

**epithermal** (ep'-i-ther'-mal) Said of a hydrothermal mineral deposit formed within about 1 kilometer of the earth's surface and in the temperature range of 50°-200°C, occurring mainly as veins. Also,

said of that environment. Cf.

*hypothermal; mesothermal.*

**epizone** (ep'-i-zone) The uppermost *depth zone* of metamorphism, characterized by low to moderate temperatures and hydrostatic pressures with low to high shearing stress. Rocks produced include slate, phyllite, and sericite and chlorite schist. Cf: *mesozone*; *katazone*.

**epoch** (ep'-och) 1. An interval of geologic time longer than an *age* and shorter than a *period*, during which the rocks of a *series* were formed. 2. An informal term used to designate a short interval of geologic time, e.g. *glacial epoch*. 3. In paleomagnetic studies, a date to which measurements of a time-varying quantity are referred. 4. *polarity epoch*.

**equal-area projection** (e'-qual ar'-e-a) 1. A map projection on which a constant ratio of areas is preserved, so that any given part of the map has the same relation to the area on the sphere it represents as the whole map has to the entire area represented. Examples include the Albers projection and the Mollweide projection. Cf: *conformal projection*. Syn: *homolographic projection*. 2. *equiareal projection*.

**equant** (e'-quant) 1. Said of a crystal having the same or nearly the same diameter in all directions. Cf: *tabular*; *prismatic*. Syn: *equidimensional*; *isometric*. 2. Said of a sedimentary particle whose length is less than 1.5 times its width. 3. Said of a rock in

which the majority of grains are

equant.

**equant element** A fabric element all of whose dimensions are approximately equal. Cf: *linear element*; *planar element*.

**equatorial projection** (e-qua-to'-ri-al) One of a group of map projections that have their center points on the equator and their polar axes vertical; e.g., the Mercator projection.

**equiareal projection** (e-qui-ar'-e-al) A term used in structural petrology for an *equal-area projection* developed from the center of a sphere through points on its surface to a plane that is tangent at the south pole of the sphere and so constructed that areas between meridians and parallels on the plane are equal to corresponding areas on the surface of the sphere.

**equigranular** (e-qui-gran'-u-lar) *homogranular*.

**equiplanation** (e'-qui-pla-na'-tion) Those processes that operate at high latitudes and tend toward reduction of the land without reference to a base-level control and without involving any loss or gain of material. Cf: *altiplanation*; *cryoplanation*.

**equipotential line** (e'-qui-po-ten'-tial) A contour line on the potentiometric surface; a line along which the pressure head of ground water in an aquifer is the same. Fluid flow is normal to these lines in the direction of decreasing fluid potential. Syn: *isopiestic line*.

**equipotential surface** A surface on which the gravity potential is

everywhere constant and to which the gravity vector is everywhere normal. The geoid is an "equipotential". Syn: *gravity equipotential surface*; *level surface*.

**equivalent** (e-quiv'-a-lent) adj. Corresponding in geologic age or stratigraphic position; esp. said of strata in different regions that are contemporaneous in time of formation or that contain the same fossil forms.—n. A stratum that is contemporaneous or equivalent in time or character.

**equivalent radius** A measure of particle size, equal to the computed radius of a hypothetical sphere of specific gravity 2.65 (quartz) having the same settling velocity and density as calculated for a given sedimentary particle in the same fluid. Cf: *nominal diameter*.

**era** A geologic-time unit next in order of magnitude below an *eon*, during which the rocks of the corresponding *erathem* were formed; e.g. the Paleozoic, Mesozoic, and Cenozoic eras. Long-recognized Precambrian eras are the Archeozoic (older) and Proterozoic (younger).

**erathem** (e'-ra-then) The largest formal chronostratigraphic unit generally recognized, ranking above *system*; the rocks formed during an *era* of geologic time, such as the Mesozoic erathem composed of the Triassic, Jurassic, and Cretaceous systems. Obsolete syn: *sequence*.

**E ray** *extraordinary ray*.

**erg** A region in the Sahara, deeply covered with shifting sand and

occupied by complex sand dunes; an extensive tract of sandy desert; a sand sea.

**Erian** (E'-ri-an) Middle Devonian of North America.

**erosion** (e-ro'-sion) The wearing-away of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, wind, and underground water. Cf: *denudation*.

**erosion scarp** A *scarp* produced by erosion, e.g. a *fault-line scarp*.

**erosion surface** A land surface shaped and subdued by the action of erosion, esp. by running water. The term is generally applied to a level or nearly level surface. Syn: *planation surface*.

**erosion thrust** A thrust fault on which the hanging wall moved across an erosion surface.

**erratic** (er-rat'-ic) n. A rock fragment carried by glacial ice, deposited at some distance from the outcrop from which it was derived, and generally resting on bedrock of different lithology. Size ranges from a pebble to a house-size block. See also: *perched boulder*. Syn: *glacial erratic*. —adj. Transported by a glacier from its place of origin.

**eruption** (e-rup'-tion) The ejection of volcanic materials (lava, pyroclasts, and volcanic gases) onto the earth's surface, either from a central vent or from a fissure or group of fissures. Cf: *central eruption*; *fissure eruption*.

**eruption cloud** A convoluted, rolling mass of partly condensed water vapor, dust, and ash, generally

highly charged with electricity, emitted from a volcano during an explosive eruption. Syn: *ash cloud*; *dust cloud*; *volcanic cloud*.

**eruptive** (e-rup'-tive) Said of a rock formed by the solidification of magma; i.e. either an *extrusive* or an *intrusive* rock. Most writers restrict the term to its extrusive or volcanic sense.

**escarpment** (es-carp'-ment) 1. A long, more or less continuous cliff or relatively steep slope facing in one general direction, separating two level or gently sloping surfaces, and produced by erosion or faulting. 2. A steep, abrupt face of rock, marking the outcrop of a resistant layer occurring in a series of gently dipping softer strata; specif. the steep face of a *cuesta*. —Syn: *scarp*.

**esker** (es'-ker) A serpentine ridge of roughly stratified gravel and sand that was deposited by a stream flowing in or beneath the ice of a stagnant or retreating glacier and was left behind when the ice melted. Length ranges from less than 100 m to more than 500 km (counting gaps), and in height from 3 to more than 300 m. Syn: *serpent kame*; *Indian ridge*.

**esker fan** A small plain of gravel and sand built at the mouth of a subglacial stream, and associated with an esker formed at the same time.

**essential mineral** (es-sen'-tial) A mineral component of a rock that is necessary to its classification and nomenclature, but is not necessarily present in large

amounts. Cf: *accessory mineral*.

**essexite** (es'-sex-ite) An alkali gabbro primarily composed of plagioclase, hornblende, biotite, and titanite, with subordinate alkali feldspar and nepheline. Essexite grades into theralite with a decrease in potassium feldspar and an increase in the feldspathoid minerals.

**estuarine** (es'-tu-a-rine) Of, pertaining to, or formed in an estuary.

**estuary** (es'-tu-ar-y) 1. The widened tidal mouth of a river valley where fresh water comes into contact with sea water and where tidal effects are evident; e.g. a *tidal river*, or a partially enclosed coastal body of water where the tide meets the current of a stream. 2. An arm of the sea affected by fresh water, e.g. the Baltic Sea. 3. A *drowned river mouth*.

**etch figure** A marking, usually in the form of minute pits, produced by a solvent on a crystal surface; the form varies with the mineral species and the solvent, but conforms to the symmetry of the crystal, hence revealing its structure.

**etching** 1. The reduction of the earth's surface by the slow processes of differential weathering, mass wasting (esp. creep), sheetwash, and deflation, so that areas underlain by more resistant rocks are brought into relief as the less resistant rocks are lowered. 2. A roughening of the surface of a sand grain or crystal through the action of a solvent.

**ethane** (eth'-ane) A colorless, odorless, water-insoluble, gaseous paraffin hydrocarbon, formula  $C_2H_6$ , which occurs in natural gas or can be produced as a by-product in the cracking of petroleum.

**encrystalline** (eu-crys'-tal-line) *macrocrystalline*.

**engeosyncline** (eu'-go-o-syn'-cline) A geosyncline in which volcanism is associated with clastic sedimentation; the volcanic part of an *orthogeosyncline*, located away from the craton. Cf: *miogeosyncline*.

**euhedral** (eu-hed'-ral) 1. Said of a mineral grain that is completely bounded by its own *rational faces*, and whose growth has not been restrained or interfered with by adjacent grains. 2. Said of the shape of such a grain.—Cf: *anhedral*; *subhedral*. Syn: *automorphic*; *idiomorphic*.

**eupelagic deposit** (eu-pe-lag'-ic) Deep-sea sediment in which less than 25% of the fraction coarser than 5 microns is of terrigenous, volcanogenic, and/or neritic origin. Such deposits accumulate by vertical settling of particulate matter, are highly oxidized, and include pelagic clays and oozes.

**euphotic zone** (eu-phot'-ic) That part of the ocean in which there is sufficient penetration of light to support photosynthesis. The depth varies, but averages about 80 m. Cf: *disphotic zone*; *aphotic zone*.

**Eurasian-Melanesian belt** (Eur-a'-sian-Mel-a-ne'-sian) The belt of major tectonic activity that ex-

tends from the Mediterranean across southern Asia to the Celebes, where it meets the *circum-Pacific belt*.

**euryhaline** (eu-ry-ha'-line) Said of a marine organism that tolerates a wide range of salinities. Cf: *stenohaline*.

**eurypterid** (eu-ryp'-ter-id) One of a group of large extinct arthropods that lived in brackish or fresh water. Range, Ordovician to Permian.

**eustatic** (eu-stat'-ic) Of or pertaining to worldwide changes of sea level

**eutaxitic** (eu-tax-it'-ic) Said of the *banded structure* of certain extrusive rocks, which results in a streaked or blotched appearance; also, said of a rock exhibiting such structure. The bands or lenses were originally ejected as individual portions of magma, were drawn out in a viscous state, and formed a heterogeneous mass in response to welding.

**eutectic** (eu-tec'-tic) Said of a system consisting of two or more solid phases and a liquid whose composition can be expressed in terms of positive quantities of the solid phases, all coexisting at the minimum melting temperature for the assemblage of solids. Addition or removal of heat causes an increase or decrease, respectively, of the proportion of liquid to solid phases, but does not change the temperature of the system or the composition of any phase.

**eutectic point** The lowest temperature at which a eutectic mixture

will melt. Syn: *eutectic temperature*.

**eutectic texture** A pattern of intergrowth of two or more minerals, formed as they coprecipitate during crystallization, e.g. the quartz and feldspar of *graphic granite*.

**eutrophication** (eu'-troph-i-ca'-tion) The process whereby a body of water becomes highly productive of aquatic plants, such as algae, due to the input of large quantities of nutrients.

**eutrophic lake** (eu-troph'-ic) A lake characterized by an abundance of dissolved plant nutrients and by a seasonal deficiency of oxygen in the bottom layers; its deposits usually have considerable amounts of rapidly decaying organic mud and its water is frequently shallow. Cf: *oligotrophic lake*; *dystrophic lake*.

**euxinic** (eux-in'-ic) 1. Pertaining to an environment of restricted circulation and stagnant or anaerobic conditions, such as a nearly isolated or silled basin with toxic bottom waters. Also, pertaining to the black organic sediments and hydrogen-sulfide muds deposited in such an environment, and to the process of deposition 2. Pertaining to a rock facies that includes black shales and related sediments. Cf: *pontic*.

**evaporates** (e-vap'-o-rates) Sedimentary salts precipitated from aqueous solution and concentrated by evaporation. The synonymous term *evaporites* is more commonly used. Cf: *reduzates*; *oxidates*; *resistates*; *hydrolyzates*.



**evaporite** (e-vap'-o-rite) One of the sediments which are deposited from aqueous solution as a result of extensive or total evaporation. Examples include anhydrite, rock salt, and various nitrates and borates. Syn: *evaporate*.

**evaporite-solution breccia** *solution breccia*.

**evapotranspiration** (e-vap'-o-tran'-spi-ra'-tion) That portion of the precipitation returned to the air through evaporation and transpiration.

**event** 1. *seismic event*. 2. A non-committal term for any incident of probable tectonic significance that is suggested by geologic evidence but whose full implications are unknown. Cf: *disturbance*.

**evolution** (e-vo-lu'-tion) 1. The theory that life on earth has developed gradually, from a few simple organisms to many complex organisms. Syn: *organic evolution*. 2. The development of a group of related organisms toward complete adaptation to the environmental conditions to which they have been exposed with the passage of time. 3. The gradual change in the form and function of organisms with geologic time, so that the latest members of the succession differ significantly from the earliest.

**exfoliation** (ex-fo'-li-a'-tion) The process by which concentric scales, plates, or shells of rock, from less than a centimeter to several meters in thickness, are successively spalled or stripped from the bare surface of a large

rock mass. It is caused by physical or chemical forces producing differential stresses within the rock. Cf: *spheroidal weathering*. **exhumed topography** (ex-humed') A land surface or feature, once buried under younger rocks, that has been exposed again by erosion.

**exogenic effect** (ex'-o-gene) The effect of an igneous mass on the rock that it invades. Cf: *endogene effect*.

**exogenetic** (ex'-o-ge-net'-ic) Said of processes originating at or near the surface of the earth, such as weathering and denudation, and to rocks, ore deposits, and landforms that owe their origin to such processes. Cf: *endogenetic*. Syn: *exogenic*; *exogenous*. **exogenous** (ex-og'-o-nous) *exogenetic*.

**exogeosyncline** (ex'-o-ge'-o-syn'-cline) A *paraogeosyncline* that lies along the cratonal border and accumulates sediments from highlands in the orthogeosynclinal belt that lies outside the craton. Syn: *deltaogeosyncline*; *foredeep*.

**exomorphism** (ex-o-mor'-phism) Changes in country rock produced by the intense heat and other properties of magma or lava in contact with them; *contact metamorphism* in the usual sense. Cf: *endomorphism*. Syn: *exometamorphism*.

**exoskeleton** (ex-o-skel'-e-ton) The external shell or platy structure of an animal, serving as a protective and supportive covering for its softer parts. Cf: *endoskeleton*.

Syn: *dermoskeleton*.

**exothermic** (ex-o-ther'-mic) Pertaining to a chemical reaction that occurs with a liberation of heat.

Ant: *endothermic*.

**exotic** (ex-ot'-ic) 1. Said of an organism that has been introduced into a new area from where it grew naturally. Ant: *indigenous*.

2. Applied to a rock body that is unrelated to the rocks with which it is associated. Exotic masses of tectonic origin are *allochthonous*; those of glacial origin are generally termed *erratics*.

**expansion fissures** (ex-pan'-sion)

A system of fissures that radiate irregularly through feldspar and other minerals adjacent to olivine crystals that have been replaced by serpentine. This replacement involves a considerable increase in volume, and the stresses produced are relieved by the fissuring of the surrounding minerals. The fissures are characteristic of norite and gabbro.

**exploration** (ex-plo-ra'-tion) 1.

The search for deposits of useful minerals or fossil fuels; *prospecting*. 2. Establishing the nature of a known mineral deposit, preparatory to *development*.

**exploratory well** (ex-plor'-a-to-ry)

A well drilled to an unexplored depth or in unproven territory, either in search of a new pool of oil or gas or with the expectation of greatly extending the limits of a known field. Cf: *development well*; *outpost well*. Syn: *test well*; *wild-cat well*.

**explorer's attitude** *Gale attitude*.

**explosion breccia** (ex-plo'-sion) A deposit of unsorted rock debris that is formed by a volcanic explosion.

**explosion caldera** A caldera resulting from a volcanic explosion. Such calderas are relatively rare, and are small in size compared to *collapse calderas*.

**explosion crater** 1. A volcanic crater formed by an explosion, commonly developed along a rift zone on the flank of a large volcano. 2. A saucer-shaped to conical crater produced experimentally by detonation of a nuclear device or a conventional explosive. 3. A meteorite crater formed by hypervelocity impact.

**explosion tuff** A tuff whose pyroclastic fragments are in the place in which they fell, rather than having been washed into place after they landed.

**explosive evolution** (ex-plo'-sive)

1. Within a group or lineage of organisms, morphologic or ecologic change at an extremely rapid rate compared to the usual or normal rate. 2. Sometimes used to denote *adaptive radiation*.

**explosive index** The percentage of pyroclastics among the total products of a volcanic eruption.

**explosive radiation** An *adaptive radiation* that appears to have occurred very rapidly.

**exsolution** (ex-so-lu'-tion) The separation of an initially homogeneous solid solution into two distinct crystalline phases without change in the bulk composition. It generally, though not

necessarily, occurs on cooling.  
Syn: *unmixing*.

**extension well** (ex-ten'-sion) Any well located as an *outpost well* or as a *wildcat well* that extends the productive area of a pool. The term cannot logically be applied until after the fact is demonstrated. Cf: *step-out*.

**external cast** (ex-ter'-nal) An improper term sometimes used as a syn. of *external mold*.

**external mold** An impression in the surrounding rock, showing the surface form and markings of the outer hard parts of a fossil shell or other organic structure; also, the surrounding rock material whose surface receives the external mold. Cf: *internal mold*; *external cast*.

**external rotation** A change in orientation of structural features during deformation referred to coordinate axes external to the deformed body. Cf: *internal rotation*.

**extinction** (ex-tinc'-tion) 1. The total disappearance of a species or higher taxon, so that it no longer exists anywhere. 2. The disappearance of a lake, by drying up or by destruction of the lake basin. 3. The darkness obtained in a *birefringent* mineral at two positions during a complete rotation of a thin section between crossed nicols; also, the darkness that persists through a rotation if the line of sight is parallel to the optic axis. Cf: *extinction angle*; *extinction direction*.

**extinction angle** The angle through which a thin section of a *birefringent* mineral must be rotated from a known crystallographic plane or direction to the position of maximum *extinction* under the petrographic microscope. The extinction angle can be diagnostic in the identification of a mineral.

**extinction direction** One of the two positions at which a section of a birefringent crystal shows *extinction* between crossed nicols.

**extraordinary ray** (ex-tra-or'-di-nar-y) In a uniaxial crystal, the ray of light that vibrates in a plane containing the optic axis and at an angle with the basal pinacoid and whose velocity or refraction approaches that of the *ordinary ray* as the angle approaches zero; the *E ray*.

**extrusion** (ex-tru'-sion) The emission of relatively viscous lava onto the earth's surface; also, the rock so formed. Cf: *effusion*.

**extrusive** (ex-tru'-sive) adj. Said of igneous rock that has been erupted onto the surface of the earth. Extrusive rocks include lava flows and pyroclastic material such as volcanic ash.—n. An extrusive rock.—Cf: *intrusive*. Syn: *effusive*; *volcanic*.

**exudation basin** (ex-u-da'-tion) A spoon-shaped depression on the ice surface at the head of an *outlet glacier*. Examples are found on the Greenland and Antarctic ice sheets.

## F

**fabric (fab'-ric)** 1. The spatial and geometrical configuration of all those components that make up a deformed rock, including texture, structure, and preferred orientation. 2. The orientation in space of the particles, crystals, and cement of which a sedimentary rock is composed. Cf: *packing*. 3. The physical nature of a soil according to the spatial arrangement of its particles and voids.

**fabric axis** One of three orthogonal axes used in structural petrology as references in the orientation of fabric elements, and in the description of folding and of the movement symmetry of deformed rocks. Cf: *a* axis; *b* axis; *c* axis. Syn: *tectonic axis*.

**fabric diagram** In structural petrology, a stereographic or equal-area projection of fabric elements. See also: *point diagram*; *contour diagram*. Syn: *petrofabric diagram*.

**fabric element** A component of a rock fabric, e.g. an *equant element*.

**face n.** 1. A planar surface bounding a crystal; a *rational face*. 2. The principal side or surface of a landform, e.g. a cliff face. 3. Any surface on which mining operations are in progress.—v. To be directed toward; e.g., vertical or inclined sedimentary beds are said to "face" in the direction of the stratigraphic top of the succession.

**facet (fac'-et)** 1. One of the plane polished surfaces on a cut gemstone. 2. A nearly plane surface produced on a rock by abrasion, as by wind sandblasting. 3. Any plane surface produced by erosion or faulting, and intersecting a general slope of the land. See also: *faceted spur*.

**faceted spur (fac'-et-ed)** A ridge, or a divide between stream valleys, that has an inverted-V face in cross section, produced by faulting or by erosion, esp. by a *valley glacier*. See also: *truncated spur*.

**facies (fa'-cies)** The aspect, appearance, and characteristics of a rock unit, usually reflecting the conditions of its origin; esp. as differentiating it from adjacent or associated units. Cf: *stratigraphic facies*; *lithofacies*; *igneous facies*. The term has been greatly overworked, and should not be used without making clear the specific kind of facies that is meant. See also: *sedimentary facies*; *petrographic facies*; *biofacies*; *environmental facies*; *metamorphic facies*. Etymol: Latin (and French), "face, form, aspect." Pron: *fay-shez* or *fay-stez*. Pl: *facies*.

**facies contour** The trace (on a map) of a vertical surface that cuts a three-dimensional rock body into facies segments; a line indicating equivalence in lithofacies development.

**facies evolution** A gradual change of facies over a period of time, indicating gradually changing depositional conditions.

**facies family** Several genetically

interconnected *facies tracts*; e.g. coral-atoll deposits and desert deposits. See also: *facies suite*.

**facies fauna** A group of animals characteristic of a given stratigraphic facies or adapted to life in a restricted environment; e.g. a black-shale fauna.

**facies fossil** A fossil, usually a species, that is restricted to a defined stratigraphic facies or is adapted to life in a restricted environment.

**facies map** A general term for a map showing the distribution of sedimentary facies occurring within a designated geologic unit, specif. a *lithofacies map*. See also: *isofacies map*; *isolith map*; *entropy map*.

**facies sequence** A succession of vertically related facies.

**facies strike** The compass direction of a *facies contour* at a given point on a map.

**facies suite** 1. Several genetically interconnected *facies families*; e.g. all marine deposits or all continental deposits. 2. A collection or group of rocks that shows variations within a single rock mass.

**facies tract** A system of genetically interconnected sedimentary facies of the same age, e.g. the outer-slope deposits of a coral atoll. It includes the areas of erosion from which the sediments of these facies are derived, so that an erosional interval represents part of a facies tract. Syn: *macrofacies*.

**facing** 1. The direction toward which a rock unit or layer becomes younger. 2. The direc-

tion along the axial plane of a fold in which it passes through younger layers.

**factor analysis** (fac'-tor) A method for identifying the minimum number of influences necessary to account for the maximum observed variation in a set of data and for indicating the extent to which each influence accounts for the variation observed.

**fairy stone** *staurulite*.

**falling dune** Sand blown off a mesa top or over a cliff, forming an extensive deposit or fan, sloping at the angle of repose of dry sand.

**fall line** An imaginary line connecting the waterfalls on adjacent near-parallel rivers, marking the points where these rivers make a sudden descent from an upland to a lowland; specif. the Fall Line marking the boundary between the crystalline rocks of the Piedmont Plateau and the sediments of the Atlantic Coastal Plain in the eastern U.S. It marks the limit of navigability of the rivers.

**fallout** 1. Fragmental material ejected from an impact or explosion crater and eventually redeposited in and around it. 2. The descent of usually radioactive particles through the atmosphere following a nuclear explosion; also, the particles themselves.

**false bedding** An old term for *cross-stratification*.

**family** (fam'-i-ly) 1. An ecologic community composed of only one kind of organism, occupying a small area and representing an early stage in a succession. 2. A

category in the hierarchy of biological classification, intermediate between *order* and *genus*. 3. The basic unit of the *clan* of igneous rocks. 4. A category of soils in U.S. Dept. of Agriculture soil taxonomy.

**fan** 1. *alluvial fan*. 2. A fan-shaped mass of congealed lava.

**fan bay** The head of an alluvial fan that extends a considerable distance into a mountain canyon.

**fan fold** A fold with a broad *hinge* region and limbs that converge away from the hinge.

**fanglomerate** (fan-glom'-er-ate) A sedimentary rock of heterogeneous materials that were originally deposited in an alluvial fan and have since become cemented into solid rock.

**fast ice** *Sea ice* that forms along and remains attached to the coast or is attached to the bottom in shallow water. It may extend a few meters to several hundred kilometers from the coastline.

**fat clay** Clay of relatively high plasticity. Ant: *lean clay*.

**fathogram** (fath'-o-gram) The graphic record produced by a *fathometer*; a type of *echogram*.

**fathom** (fath'-om) A unit of measurement used for soundings. It is equal to 1.83 meters (6 feet).

**fathometer** (fa-thom'-e-ter) A copyrighted name for a type of *echo sounder*. See also: *fathogram*.

**fatigue limit** (fa-tigue') *endurance limit*.

**fault** A fracture or fracture zone along which there has been dis-

placement of the sides relative to one another parallel to the fracture.

**fault basin** A depression separated from the surrounding area by faults.

**fault block** A crustal unit bounded by faults, either completely or in part. It behaves as a unit during faulting and tectonic activity. An example is the Sierra Nevada of California.

**fault-block mountain** *block mountain*.

**fault breccia** Angular fragments resulting from the crushing, shattering, or shearing of rocks during movement on a fault or in a fault zone.

**fault complex** An intricate system of interconnecting and intersecting faults of the same or different ages.

**fault embayment** A depressed region in a fault zone or between two faults that has been invaded by the sea, e.g. the Red Sea, or Tomales Bay on the San Andreas fault.

**fault escarpment** *fault scarp*.

**fault gouge** Pulverized claylike material, commonly a mixture of minerals, found along some faults; a slippery mud that coats the fault surface or cements the *fault breccia*. It is formed by the grinding of rock material as the fault developed, as well as by decomposition caused by circulating solutions.

**faulting** The process of fracturing and displacement that produces a *fault*.

**fault line** The intersection of a fault with the surface of the earth, or the trace of a fault on a surface of reference.

**fault-line scarp** A cliff or escarpment formed by differential erosion along a fault line. See also: *obsequent fault-line scarp*; *resequent fault-line scarp*.

**fault plane** A fault surface that is more or less planar.

**fault scarp** The cliff or escarpment formed by a fault that reaches the earth's surface. Most fault scarps have been modified by erosion since the faulting. Cf: *fault-line scarp*.

**fault set** A group of faults that are parallel or nearly so, and that are related to a particular deformational episode. Cf: *fault system*.

**fault splinter** A connecting ramp-like structure between opposite ends of two parallel normal faults.

**fault spring** A spring emerging from a fault on which an aquifer is in contact with an impermeable bed.

**fault surface** The surface along which dislocation on a fault has taken place. Cf: *fault plane*.

**fault system** 1. Two or more interconnecting *fault sets*. 2. A syn. of *fault set*.

**fault trap** An oil or gas trap in which the *closure* results from the presence of one or more faults.

**fault valley** A linear depression produced by faulting; e.g. a large graben situated between tilted block mountains.

**fault zone** A fault that is expressed as a zone of numerous small frac-

tures or of fault breccia or gouge. A fault zone may be hundreds of meters wide.

**fauna** (fau'-na) The entire animal population, living or fossil, of a given area, environment, formation, or time span. Cf: *flora*; *biota*.

**faunal** (fau'-nal) Of or pertaining to a fauna.

**faunal break** An abrupt change from one fossil assemblage to another in a stratigraphic sequence.

**faunal province** A region characterized by a specific assemblage of animals more or less widely distributed within it.

**faunal succession** The observed chronologic sequence of life forms (esp. animals) through geologic time. See also: *law of faunal succession*.

**faunizone** (fau'-ni-zone) A body of strata characterized by a particular fossil fauna, which may have chronological or only environmental significance. The term is not generally accepted, and its correct definition is in dispute. Cf: *florizone*.

**faunule** (fau'-nule) 1. A collection of fossil animals obtained from a stratum over a very limited geographic area, esp. from only one outcrop. Syn: *local fauna*. 2. An assemblage of fossil animals in a single stratum or a few contiguous strata, dominated by the representatives of one community.

***f* axis** A term used in crystal plasticity to denote a line in the crystal slip plane at right angles to the

slip direction ( $\epsilon$  direction). It is commonly an axis of rotation of the crystal lattice during deformation.

**fayalite** (fa'-yal-ite) A brown to black mineral of the olivine group,  $\text{Fe}_2\text{SiO}_4$ . It is isomorphous with forsterite, and occurs chiefly in igneous rocks.

**feather edge** The thin edge of a bed of sedimentary rock where it disappears by thinning, pinching, or wedging out.

**feather jointing** A joint pattern formed in a fault zone by shear and tension. The joints appear to the fault as the barbs of a feather to its shaft. Syn: *pinnate jointing*.

**fecal pellet** (fe'-cal) Excreta, mainly of invertebrates, present esp. in modern marine deposits but also as fossils in sedimentary rocks. Most are of simple ovoid form and 1 mm. or less in length, i.e. smaller than *coprolites*.

**feeder** 1. The conduit through which magma passes from the magma chamber to some localized intrusion, e.g. a feeder dike. 2. An opening or passage in a rock through which mineral-bearing solutions may move. Syn: *channelway*. 3. *tributary*.

**feeder current** The part of a rip current that flows parallel to the shore (inside the breakers) before converging with other feeder currents to form the neck of the rip current.

**feldspar** (feld'-spar) 1. A group of abundant rock-forming minerals of the general formula,  $\text{MAl}(\text{Al}, \text{Si})_3\text{O}_8$ , where M can be K, Na,

Ca, Ba, Rb, Sr, or Fe. Feldspars are the most widespread of any mineral group and constitute 60% of the earth's crust; they occur in all types of rock. Feldspars are white and gray to pink, have a hardness of 6, are commonly twinned, have monoclinic or triclinic symmetry, and show good cleavage in two directions. 2. A mineral of the feldspar group, such as microcline.—Adj: *feldspathic*.

**feldspathic** (feld'-spath'-ic) Said of a rock or other mineral aggregate containing feldspar.

**feldspathic sandstone** A sandstone containing from 10 to 25% feldspar, intermediate in composition between a quartz sandstone and an *arkosic sandstone*. Approx. syn: *subarkose*.

**feldspathoid** (feld'-spath'-oid) 1. A group of comparatively rare rock-forming minerals related to the feldspars but containing less silica. Feldspathoids take the place of feldspars in igneous rocks that are undersaturated with respect to silica; they are never found in the same rock with quartz. Syn: *foid*; *leucad*. 2. One of the minerals of the feldspathoid group, e.g. leucite or nepheline.

**felsic** (fel'-ic) A mnemonic adjective derived from *feldspar* + *leucad* (feldspathoid) + *silica* + *c* and applied to an igneous rock having abundant light-colored minerals; also, applied to those minerals (quartz, feldspars, feldspathoids, muscovite) as a group. It is the complement of *mafic*. Cf:



*femic; salic.*

**felsite** (fel'-site) A general term for any light-colored, aphanitic igneous rock, with or without phenocrysts and composed chiefly of quartz and feldspar; a rock characterized by *felsitic* texture. Syn: *aphanite*.

**felsitic** (fel-sit'-ic) Pertaining to felsite.

**felty pilosulitic.**

**femic** (fem'-ic) Said of an igneous rock having one or more normative, dark-colored iron-, magnesium-, or calcium-rich minerals as the major components of the norm; also, said of such minerals. Etymol: a mnemonic term derived from *ferric* + *magnesium* + *ic*. The corresponding term for the ferromagnesian minerals actually present in a rock is *mafic*.

**fence diagram** 1. A drawing in perspective of three or more geologic sections, showing their relationships to one another. 2. A diagram of chemical factors, such as Eh and pH, that influence mineral stability, having discrete fields defined by boundaries between phases in an assemblage of minerals, rocks, or compounds.

**fenestrate** (fe'-nes-trate) Having openings or transparent areas; perforated or reticulated. The term has been applied esp. to bryozoans, corals, and pollen.

**fenster** (fen'-ster) *window*.

**Ferrel's law** (Fer'-rel's) A statement that the *Coriolis force* deflects currents of air or water to the right in the northern hemisphere and to the left in the southern.

**ferricrete** (fer'-ri-crete) 1. A conglomerate consisting of surficial sand and gravel cemented into a hard mass by iron oxide. 2. A ferruginous *duricrust*. —Etymol: *ferruginous* + *concrete*. Cf: *calcrete*; *silcrete*.

**ferriferous** (fer-rif'-er-ous) Iron-bearing; said esp. of a mineral containing iron, or of a sedimentary rock that is richer in iron than is usually the case, such as a shale whose iron-oxide content is greater than 15%. Cf: *ferruginous*.

**ferroalloy** (fer-ro-al'-loy) A metal whose chief use is for alloying with iron to produce special quality steel. Ferroalloy metals include manganese, nickel, chromium, tungsten, molybdenum, vanadium, cobalt, and titanium.

**ferromagnesian** (fer'-ro-mag-ne'-sian) Containing iron and magnesium; applied to *mafic* minerals, esp. amphibole, pyroxene, biotite, and olivine.

**ferruginous** (fer-ru'-gi-nous) 1. Pertaining to or containing iron, e.g. a sandstone that is cemented with iron oxide. Cf: *ferriferous*. 2. Said of a rock having a red or rusty color due to the presence of ferric oxide (the quantity of which may be very small).

**festoon cross-bedding** (fes-toon') A type of *cross-lamination*. It consists of elongate, eroded, plunging troughs that are filled by sets of thin laminae conforming in general to the shapes of the troughs, and that crosscut each

other so that only parts of each unit are preserved, resulting in a festoonlike (looped or curved) appearance in section.

**fibroblastic** (fi-bro-blas'-tic) Pertaining to a type of texture in metamorphic rocks resulting from development during recrystallization of minerals with even grain size and fibrous habit. Cf: *nematoblastic*.

**fibrous texture** (fi'-brous) In mineral deposits, a pattern of finely acicular, rodlike crystals, e.g. in chrysotile and amphibole asbestos. See also: *cross-fiber*.

**fiducial time** (fi-du'-cial) A time marked on a seismic record to correspond to some arbitrary time. Such marks may aid in synchronizing different records, or may indicate a reference, such as a *datum plane*.

**field** 1. A broad term for the area, away from the laboratory and esp. outdoors, where a geologist makes observations and collects data and specimens. 2. A region that is known for a particular mineral resource, e.g. coal field, gold field. 3. That space in which an electric, gravitational, or magnetic effect occurs and is measurable. It has continuity, i.e. there is a value associated with every location within the space. 4. *ice field*.

**field capacity** The quantity of water held by soil or rock against the pull of gravity. It is sometimes limited to a certain drainage period, thereby distinguishing it from *specific retention* which is not

limited by time.

**field classification** A preliminary analysis of fossils, or of hand specimens of rocks or minerals, in the field, usually with the aid of a hand lens.

**field focus** The total area or volume that is the source of an earthquake, inferred from the area of shaking as observed in the field. The concept is inexact and the term is not commonly used.

**field geology** Geology as practiced by direct observation in the field.

**field ice** 1. A general term for all types of *sea ice* except that newly formed. 2. An obsolete term for large flat areas of consolidated *pack ice*.

**field intensity** The force of attraction exerted on a unit mass particle at a point by the matter causing the force field.

**field well** A well drilled for oil or gas within the area of a pool that has already been essentially proved for production.

**figure of the earth** The *geoid*, or surface of the earth, as approximated by mean sea level over the oceans and the sea-level surface extended continuously through the continents.

**filliform** (fil'-i-form) *capillary*.

**fill** 1. Man-made deposits of rock, soil, tailings, or the like, used for extending a shoreline into a lake, building embankments or highway grades, or filling abandoned mine workings. 2. Sediment deposited by any agent so as to fill or partly fill a valley or other low place. 3. Detrital material partly

or completely filling a cave.

**filler mineral filler.**

**fill terrace** A remnant, resulting from stream rejuvenation, of a flat valley bottom or alluvial plain that had been produced by stream aggradation.

**filter** A device that changes the wave form or amplitude of a seismic signal. It may be electrical or mechanical, or it may be a computer. The earth acts as a filter to seismic waves.

**filter pressing** A process of magmatic differentiation wherein a magma, having crystallized to a "mush" of interlocking crystals in liquid, is compressed by earth movements, forcing the liquid to move toward regions of lower pressure and to become separated from the crystals.

**fine aggregate** The portion of an aggregate consisting of particles with diameters smaller than approximately 1/4 inch or 4.76 mm.

Cf: *coarse aggregate*.

**fine-grained** 1. Said of an igneous rock, and of its texture, whose particles have an average diameter less than 1 mm (0.04 in.). Syn: *aphanitic*. 2. Said of a sedimentary rock, and of its texture, in which the particles have an average diameter less than 1/16 mm (62 microns, or silt size and smaller). The term is used in a relative sense, and various size limits have been utilized. Cf: *coarse-grained*; *medium-grained*.

**fineness factor** A measure of the average particle size of clay and ceramic material, computed by

summing the products of the reciprocal of the size-grade mid-points and the weight percentage of material in each class (expressed as a decimal part of the total frequency). It is based on the assumption that the surface areas of two powders are inversely proportional to their average particle sizes.

**finer** 1. Finely crushed coal or ore, esp. material smaller than the minimum specified size. 2. Very small particles in a mixture of various sizes, e.g. the silt and clay fraction in glacial drift.

**fine sand** Sand with particle diameters in the range of 0.125 to 0.25 mm.

**finger lake (fin'-ger)** A long, narrow lake, which may occupy the floor of a glacial trough or be held in by a morainal dam, esp. one of a group of such lakes disposed somewhat like the fingers of a hand, e.g. the Finger Lakes in central New York State.

**fiord fjord.**

**fire assay** The assaying of metallic ores, usually of gold and silver, by methods requiring furnace heat.

**fireclay** 1. A siliceous or aluminous clay capable of withstanding high temperatures without deforming, and useful for the manufacture of refractory products such as crucibles and firebrick. It approaches kaolin in composition. 2. A term inaccurately used for *underclay*. —Also spelled: *fire clay*. Syn: *refractory clay*

**fireclay mineral** A disordered variety of kaolinite. Syn: *mellorite*.

**firedamp** An explosive coal-mine gas consisting mainly of methane.

**firerising** The rhythmic eruption of gas-charged lava (normally basaltic) from a volcanic vent, either a localized central vent or a fissure, forming a fountain of molten rock.

**fire opal** A transparent to translucent variety of opal that gives out fiery reflections in bright light and may or may not have play of color.

**firn** A material transitional between snow and glacier ice. Snow becomes firn after existing through one summer melt season; firn becomes glacier ice when its permeability to liquid water drops to zero. *Syn:* *névé*.

**firn basin** *firn field*.

**firn field** The accumulation area of a glacier; a broad expanse of glacier surface over which snow accumulates and firn is created.

*Syn:* *firn basin; névé*

**firn limit** *firn line*.

**firn line** The highest level on a glacier to which the winter snow cover recedes during the summer season; the *snowline*. *Syn:* *firn limit*.

**first arrival** The first energy to arrive from a seismic source. First arrivals on reflection records are used for information about a surficial low-velocity or weathering layer; refraction studies are often based on first arrivals.

**first law of thermodynamics** The statement describing the internal energy of a system, which says that the change of energy of the system is equal to the amount of

energy received from the external world. This in turn equals the heat taken in by the system and the work done on it.

**firth** A long, narrow arm of the sea; also, the opening of a river into the sea. It is commonly the lower part of an *estuary*.

**fishing** The operation of attempting to recover a piece of drilling or other equipment broken off or lost from the drilling tools and accidentally dropped into the hole.

**fissile** (fis'-sile) Capable of being easily split along closely spaced planes; exhibiting *fissility*.

**fissility** (fis-sil'-i-ty) The property of splitting easily along closely spaced parallel planes, e.g. bedding in shale or cleavage in schist. *Adj:* *fissile*.

**fission** 1. The spontaneous or induced splitting, by particle collision, of a heavy nucleus into a pair of nearly equal fission fragments plus some neutrons. It is accompanied by the release of large amounts of energy. *Cf:* *fusion*. 2. Asexual reproduction occurring when a single cell or polyp divides into two equal parts.

**fissure** (fis'-sure) 1. An extensive crack, break, or fracture in the rocks. It may contain mineral-bearing material. 2. *crevasse*.

**fissure eruption** An eruption that takes place from an elongate fissure, rather than from a central vent. *Cf:* *central eruption*.

**fissure polygon** A *nonsorted polygon* marked by intersecting grooves or fissures producing a

gently convex polygonal surface pattern and by the absence of a well-defined stone border. It is typical of broad areas of the NW Canadian lowlands. See also: *mud polygon*; *ice-wedge polygon*.

**flasure vein** A type of mineral deposit of veinlike shape, with clearly defined walls rather than extensive host-rock replacement.

**fixed carbon** In coal, coke, and bituminous materials, the solid combustible matter remaining after removal of moisture, ash, and volatile matter. It is expressed as a percentage.

**fixed ground water** Ground water held in saturated material with interstices so small that it is attached to the pore walls, and is not available as a source of water for pumping.

**fjord (fiord)** A long narrow arm of the sea, in a valley that is U-shaped and steep-walled, generally several hundred meters deep, with high rocky cliffs or slopes along a mountainous coast; typically with a shallow sill submerged near its mouth, and becoming deeper inland. A fiord usually represents the seaward end of a deeply excavated glacial-trough valley that was partially submerged by drowning after melting of the ice.

**flags** Thin-bedded, hard sandstone or limestone layers that can be used for flagstones.

**flagstone** 1. A hard sandstone, usually micaceous and fine-grained, that occurs in extensive thin beds with shale partings; it

splits uniformly along bedding planes into thin slabs suitable for use in terrace floors, retaining walls, and the like. Cf: *bluestone*.

2. A flat slab of stone used for paving.

**flake graphite** In economic geology, graphite disseminated in metamorphic rock as thin, visible flakes that are separable from the rock by mechanical means.

**flake mica** Finely divided mica recovered from mica schist or sericite schist or obtained as a by-product of beneficiation of feldspar or kaolin.

**flame structure** 1. A sedimentary structure consisting of wave- or flame-shaped plumes of mud that have been squeezed irregularly upward into an overlying layer. It is a result of differential settling and compaction. 2. Dark vitric lenses in welded tuff, averaging a few centimeters in length, perhaps formed by collapse of fragments of pumice.

**flame test** A qualitative analysis of a mineral made by intensely heating a sample in a flame and observing the flame's color, which will be indicative of the elements involved, e.g. green from copper.

**flank limb**

**flanking moraine** A moraine left by a glacial lobe or by a tongue-like projection of an ice sheet. Cf: *lateral moraine*.

**flaser (fla'-ser)** Streaky, parallel layers surrounding the granular lenticular bodies in flaser structure.

**flaser gabbro** A coarse-grained

catclastic gabbro in which flakes of mica or chlorite sweep around lenses (*augen*) of feldspar and quartz with recrystallization and the formation of new minerals. Cf: *mylonite*.

**flaser structure** 1. A structure in dynamically metamorphosed rocks in which lenses of original granular minerals are surrounded by highly sheared and crushed material, giving the appearance of crude flow structure. Cf. *augen structure*. 2. *Cross-lamination* in which mud streaks are preserved in the troughs of ripples but incompletely or not at all on the crests.

**flat** 1. A tract of low-lying, level wetland, e.g. a swamp in a river valley. Cf: *bottom*. 2. A level or nearly level surface, e.g. a *valley flat*. 3. A horizontal orebody.

**flatiron** (flat'-i-ron) One of a series of short, triangular spurs or ridges on the flank of a mountain, having a sharp apex and a broad base, resem. g a huge flatiron; it usually consists of a plate of steeply inclined resistant rock between deep valleys.

**flat joint** In igneous rocks, a joint dipping at an angle of 45° or less, randomly oriented with respect to others.

**flatness** 1. A measure of the shape of a pebble given by the ratio of the radius of curvature of the most convex portion of the flattest face to the mean radius of the pebble. 2. A measure of the shape of a pebble given by the arithmetic mean of the long and intermedi-

ate diameters (length and width) divided by the short diameter (thickness).—Cf: *roundness*.

**flats and pitches** A phrase descriptive of the structure of the lead and zinc deposits in dolomite of the Upper Mississippi Valley region of the U.S., esp. in Wisconsin. The "flats" are nearly horizontal solution openings; the "pitches" are the inclined, interconnecting joints. Syn: *pitches and flats*.

**flaw** 1. Any imperfection of a fashioned gemstone, such as a crack or inclusion. 2. A narrow zone between pack ice and fast ice, not wide enough for a navigable vessel. 3. An old term for a strike-slip fault

**flaxseed ore** An iron-bearing sedimentary deposit, e.g. the *Clinton ore*, composed of hematitic oolites that have been somewhat flattened parallel to the bedding plane. Cf: *fossil ore*.

**F layer** The seismic region of the earth from 4710 km to 5160 km, equivalent to the transition zone between the outer core and the inner core. It is a part of a classification of the earth's interior made up of layers A to G. Together with the G layer, it is the equivalent of the *lower core*.

**flexible** (flex'-i-ble) Said of a mineral which can be bent without breaking but will not return to its original form, e.g. talc.

**flexible sandstone** *itacolumite*.

**flexural slip** (flex'-ur-al) *bedding-plane slip*.

**flexure** (flex'-ure) *hinge*.

**flexure fault** *growth fault.*

**flexure-flow fold** A fold in which the mechanism of folding includes displacement parallel to layer boundaries and some flow within layers, resulting in thickening of hinge areas and thinning of limbs Cf. *flexure-slip fold*

**flexure-slip fold** A fold in which the mechanism of folding is slip along bedding planes or along surfaces of foliation. There is no change in thickness of individual strata, and the resultant folds are parallel Cf. *flexure-flow fold*.

**flint** The dark gray or black variety of *chert*.

**flint clay** A smooth, flintlike microcrystalline clay rock composed dominantly of kaolin, which breaks with a pronounced conchoidal fracture and resists slaking in water. It becomes plastic upon prolonged grinding in water.

**float** A general term for isolated, displaced fragments of a rock, esp. on a hillside below an outcropping ledge or vein Cf. *float ore*.

**floating sand grain** An isolated grain of quartz that is not, or does not appear to be, in contact with neighboring sand grains scattered throughout the finer-grained matrix of a sedimentary rock, esp. of a limestone, e.g. a grain surrounded on all sides by coarse mosaic of calcite cement.

**float ore** Fragments of vein material found on the surface, usually downhill from the outcrop; a type of *float*.

**flocculation** (floc-cu-la'-tion) The process by which many minute suspended particles are held together in clotlike masses, or are loosely aggregated into small lumps or granules; e.g. the deposition or settling-out of clay particles in salt water.

**floe** A mass of floating ice, 20 m to as much as 10 km across, not attached to a shore.

**floeberg** (floc'-berg) A massive piece of sea ice composed of one or more hummocks, frozen together and floating free, with its highest point up to 5 m above sea level. It resembles a small iceberg.

**floe till** *berg till*.

**flood** Any relatively high streamflow that overtops the stream banks in any part of its course, covering land that is not normally under water.

**flood basalt** *plateau basalt*.

**flood basin** 1. The tract of land covered by water during the highest known flood. 2. The broad, flat area between a sloping plain and the natural levee of a river, occupied by heavy soils and commonly having swampy vegetation.

**flood current** The movement of water toward the shore or up an estuary with increase in the height of a tide. Cf. *ebb current*.

**flood frequency** The average occurrence of flooding of a given magnitude, over a period of years.

**flooding** 1. Inundation of the land surface by water. 2. A term sometimes used in the oil industry for *waterflooding*.

**flood peak** The maximum rate of flow attained at a given point during a flood.

**flood plain** That portion of a river valley, adjacent to the channel, which is built of sediments deposited during the present regimen of the stream and is covered with water when the river overflows its banks at flood stages.

**flood-plain meander scar** A crescentic mark indicating the former position of a river meander on a flood plain.

**flood-plain scroll** One of a series of short, crescentic, slightly sinuous strips or patches of coarse alluvium formed along the inner bank of a stream meander and representing the beginnings of a flood plain.

**flood tide** That part of the tide cycle between low water and the following high water, characterized by advancing or shoreward movement of water. Syn: *rising tide*.

**floodway** A large-capacity channel constructed to divert floodwaters safely through or around populated areas.

**floor** 1. The bed of any body of water. 2. *valley floor*. 3. The *foot-wall* of a horizontal orebody. 4. A rock surface, generally eroded, on which sedimentary strata have been deposited.

**flora** (flo'-ra) The entire plant population of a given area, environment, formation, or time span. Cf: *fauna*.

**florizone** (flor'-i-zone) A body of strata characterized by a particular fossil flora, which may have

chronological or only environmental significance. The term is not generally accepted, and its correct definition is in dispute. Cf: *faunizone*.

**flotation** (flo-ta'-tion) 1. *crystal flotation*. 2. *froth flotation*.

**flow** 1. The movement of water, and the moving water itself; also, the rate of movement. 2. A mass movement of unconsolidated material in the plastic or semifluid state, e.g. a mudflow; also, the mass of material so moved. 3. Any rock deformation that is not instantly recoverable without permanent loss of cohesion, e.g. recrystallization. 4. *glacier flow*. 5. *lava flow*.

**flowage fold** (flow'-age) A fold in relatively plastic rocks that have flowed toward the synclinal trough. In this type of deformation, there are no apparent surfaces of slip. Syn: *flow fold*. Cf: *reverse-flowage fold*.

**flow breccia** A type of lava flow, usually of silicic composition, in which fragments of solidified or partly solidified lava, produced by explosion or flowage, have become welded together or cemented by the still fluid parts of the same flow.

**flow cast** A lobate ridge or other raised feature produced on the underside of a sand layer by the sand's flowing into a depression in underlying soft hydroplastic sediment. The underlying rock, typically shale or mudstone, preserves no diagnostic structure. See also: *flute cast*.



**flow cleavage** A syn. of *slaty cleavage*, so called because of the assumption that recrystallization of the platy minerals is accompanied by rock flowage.

**flow fold** *flowage fold*.

**flow gneiss** Gneiss whose structure was produced by flowage in an igneous mass before complete solidification.

**flowing artesian well** An *artesian well* whose head is sufficient to raise the water above the land surface. Cf. *nonflowing artesian well*; *flowing well*.

**flowing well** A well from which water or oil flows without pumping.

**flow layer** A rock layer differing in composition or texture from adjacent layers, produced by flowage before complete consolidation of magma. Cf. *flow line*.

**flow layering** The structure of an igneous rock, characterized by layers differing in color, mineralogic composition, and/or texture, formed as a result of the flow of magma or lava. Syn. *flow banding*. See also *banding*.

**flow line** A lineation of crystals, mineral streaks, or inclusions in an igneous rock, indicating the direction of flow before consolidation. Cf. *flow layer*.

**flow plane** The plane along which displacement occurs in both igneous and metamorphic rocks. In the former it is a *flow layer*. In the latter, it is generally subparallel to the *foliation* visible in hand specimens.

**flow roll** A rounded, pillowlike

mass of sandstone, commonly in the basal part of a sandstone bed overlying shale or mudstone, presumed to form soon after deposition by flowage of the underlying mud and slump or foundering of sand.

**flowstone** A general term for any deposit of calcium carbonate or other mineral formed by flowing water on the walls or floor of a cave. See also. *dripstone*; *travertine*; *cave onyx*.

**flow texture** A texture common in the glassy groundmass of extrusive rocks, especially lavas, in which the flow lines of the once molten material are revealed by a subparallel arrangement of prismatic or tabular crystals or microlites.

**flow unit** A group of sheets or beds of lava or pyroclasts that were formed by a single eruption or outpouring.

**fluid** adj. Able to flow, i.e. to move and change shape without separating when under pressure.—n. Any substance that can flow, liquid or gas.

**fluid inclusion** A tiny cavity in a mineral, 1.0-100.0 microns in diameter, containing liquid and/or gas, formed by the entrapment in crystal irregularities of fluid, commonly that from which the rock crystallized.

**flume** 1. A deep, narrow ravine or gorge, with nearly perpendicular walls and a stream forming a series of cascades. 2. A channel, either natural or man-made, that carries water for irrigation, min-

ing, logging, or other industrial uses.

**fluorapatite** (flu-or-ap'-a-tite) 1. A mineral of the apatite group,  $\text{Ca}_5(\text{PO}_4)_3\text{F}$ . It is a common accessory mineral in igneous rocks. 2. An apatite mineral in which fluorine predominates over chlorine and hydroxyl. See also *apatite*.

**fluorescence** (flu-o-res'-cence)

Emission of visible light by a substance exposed to ultraviolet light. It is useful in examining well cuttings for oil traces and in prospecting for some minerals.

**fluoride** (flu'-o-ride) A compound of fluorine with another element or with a radical.

**fluorine dating** Determination of the relative age of Pleistocene or Holocene bones, based on the gradual combination of fluorine in ground water with the calcium phosphate of buried bone material.

**fluorite** (flu'-o-rite) A clear to translucent mineral,  $\text{CaF}_2$ . It is commonly blue or purple, but occurs in many other colors; it is found in cubic crystals and has perfect basal cleavage. Fluorite is a common mineral in veins, is the ore of fluorine, and is used in glass and enamel and in the manufacture of hydrofluoric acid. Syn *fluorspar*.

**fluorspar** (flu'-or-spar) Commercial name for fluorite.

**flute** 1. A primary sedimentary structure, commonly seen as a *flute cast*, consisting of a discontinuous scoop-shaped or lobate depression or groove, up to about 10 cm in length, formed by a tur-

bulent sediment-laden current scouring a muddy bottom. 2. A small vertical channel or groove formed by differential weathering on an exposed rock face or by solution in a cave shaft.

**flute cast** A *sole mark* consisting of a raised oblong bulge on the under side of a siltstone or sandstone bed. It is formed by the filling of a *flute*. See also *flow cast*.

**fluting** 1. Differential weathering and erosion by which an exposed well-jointed coarse-grained rock, such as granite, develops a corrugated surface of *flutes*. 2. The formation by glacial action of smooth gutterlike channels or furrows on the face of a rock mass obstructing glacial advance. Also, grooves and ridges in till, parallel to the direction of ice movement. 3. The process of forming a *flute* by the scouring action of a current of water on a muddy surface.

**fluvial** (flu'-vi-al) Of or pertaining to rivers, growing or living in a stream or river produced by the action of a stream or river. See also *fluvatile*.

**fluvial cycle of erosion** The complete reduction or lowering of a region to base level largely by running water, specific the action of rivers. Syn *normal cycle*.

**fluvatile** (flu'-vi-a-tile) Belonging to a river, produced by river action, growing or living in freshwater rivers. An approximate synonym of *fluvial*. It is esp. used for the physical products of river action, e.g. *fluvatile dam*.

**fluvatile dam** A dam formed in a

stream channel by sediment deposited by a tributary

**fluviation** (flu-vi-ation) The activities engaged in and the various processes employed by, streams

**fluvio-glacial** (flu-vo-gla-sia) *glacial fluvial*

**flux** 1 A substance that reduces the melting point of a mixture as in making glass or ceramics or in the pyrometals to fire 2 *flux* (iron) A flux is used with water 4 The number of radioactive particles in a given volume times their mean velocity

**fluxing ore** An ore containing an appreciable amount of valuable metal but smelted mainly because it contains fluxing agents that do not have to be added as in the reduction of richer ores

**fluxstone** Limestone, dolomite, or other rock or mineral used in metallurgical processes to lower the fusion temperature of the ore, combine with impurities and make a fluid slag Syn *flux*

**fly ash** All solids, including ash, charred paper, cinders, dust, and soot that are carried in a gas stream esp in stack gases at a coal-fired power plant

**flying magnetometer** *aerborne magnetometer*

**flysch** (fish) A marine sedimentary facies characterized by a thick sequence of poorly fossiliferous, thinly bedded, graded marls and sandy and calcareous shales and muds, rhythmically interbedded with conglomerates, coarse sandstones, and grav-

wackes, specif the Flysch strata (Upper Cretaceous to Oligocene) along the borders of the Alps, deposited in foredeeps in front of northward advancing *nappes* prior to the main (Miocene) phase of the Alpine orogeny Cf *molasse* **focal sphere** (fo'-cal) An arbitrary reference sphere drawn about the epicenter or focus of an earthquake, to which body waves recorded at the earth's surface are projected for studies of earthquake mechanisms

**focus** (fo'-cus) The initial rupture point of an earthquake, where strain energy is first converted to elastic wave energy the point within the earth that is the center of an earthquake Syn *seismic focus* Cf *epicenter*

**ford** A collective term coined by Johanssen in 1917 to denote the *feldspathoid* group of minerals *Pyroxene feldspathoid*

**fold** 1 A bend or plication in bedding, foliation, cleavage, or other planar features in rocks A fold is usually a product of deformation, but the definition does not specify manner of origin 2 A broad median external undulation or plica on either the dorsal or the ventral valve of a brachiopod

**fold belt** *orogenic belt*

**fold fault** An overfold the middle limb of which is replaced by a fault surface

**fold mountains** Mountains that have been formed by the large-scale folding and later uplift and deep erosion of stratified rocks

**fold system** A group of congruent

folds that are produced by the same tectonic episode.

**foliate** (fo'-li-ate) 1. Adj. of *foliation*. 2. A general term for any foliated rock.

**foliation** (fo-li-a'-tion) 1. A planar arrangement of textural or structural features in any type of rock; esp. the planar structure that results from flattening of the constituent grains of a metamorphic rock. Adj: *foliate*; *foliated*. 2. The layered structure produced in the ice of a glacier by plastic deformation. Syn: *banding*.

**fondo** (fon'-do) adj. A term applied to the environment of sedimentation that lies on the deep floor of a water body. It may be used alone or as a combining form. See also: *fondoform*, *fondothem*. Cf: *clino*; *unda*

**fondoform** (fon'-do-form) The underwater landform constituting the main floor of a water body. It is the site of the *fondo* environment of deposition. Cf: *clinoform*; *undafurm*.

**fondothem** (fon'-do-them) Rock units formed in the *fondo* environment of deposition. Cf: *clinothem*; *undathem*.

**food chain** The sequence of organisms in which each is food for a higher member of the sequence.

**food cycle** All the *food chains* in an association of organisms; the food relations between the members of a population that make it possible for the population to survive.

**fool's gold** A popular term for pyrites resembling gold in color;

specif. pyrite and chalcopyrite.

**foot** 1. The bottom of a slope, grade, or declivity. Cf: *head*. 2. The lower bend of a *structural terrace*. 3. In a landslide, the buried line of intersection between the surface of rupture and the original ground surface. 4. The ventral part of the body of a mollusk, used for creeping in gastropods and for burrowing in bivalve forms.

**footwall** The mass of rock beneath a fault, orebody, or mine working; esp. the wall rock beneath an inclined vein or fault. Cf: *hanging wall*.

**foram** (for'-am) *foraminifer*.

**foraminifer** (for-a-min'-i-fer) Any protozoan belonging to the subclass Sarcodina, order Foraminifera, characterized by a test of one to many chambers composed of calcite or of agglutinated particles. Most foraminifers are marine Range, Cambrian to the present. Syn: *foram*

**forced folding** Deformation of the sedimentary strata above the crystalline basement by dominantly vertical movement along faults, many of which are curved in cross section This structural style is well developed in the Rocky Mountains foreland. See also: *drape fold*.

**forcible intrusion** (forc'-i-ble) Emplacement of magma that forcibly created the space into which it moved; also, the magma or rock body so emplaced Cf: *permissive intrusion*. Syn. *aggressive intrusion*.

**foredeep** 1. An elongate depression bordering an island arc or other orogenic belt. 2. *exogeosyncline*.

**foredune** A coastal dune at the landward margin of a beach or along the shoreward face of a beach ridge, more or less completely stabilized by vegetation.

**foreland** 1. A stable area marginal to an orogenic belt, toward which the rocks of the belt were thrust or overfolded. Generally the foreland is a continental part of the crust, and is the edge of the craton or platform area. 2. A headland or promontory.

**forelimb** The steeper of the two limbs of an asymmetrical, anticlinal fold. Cf: *backlimb*.

**forensic geology** (fo-ren'-sic) Application of the earth sciences to the law. Syn. *legal geology*.

**fore reef** The seaward side of a reef, in places a steep slope covered with deposits of reef talus, elsewhere an organism-constructed vertical wall. Cf: *back reef*. Also spelled: *forereef*.

**foreset beds** Inclined layers of a cross-bedded unit, specif. on the frontal slope of a delta or the lee side of a dune. They represent the greater part of the bulk of a delta. Cf: *bottomset beds*; *topset beds*. Syn: *foresets*.

**foreshock** A small tremor that commonly precedes a larger earthquake by an interval ranging from seconds to weeks and that originates at or near the focus of the larger earthquake. Cf: *after-shock*.

**foreshore** The zone of the shore or

beach that is regularly covered and uncovered by the rise and fall of the tide. Syn: *beach face*. Cf: *backshore*.

**foresight** A sight on a new survey point, taken in a forward direction and made in order to determine its bearing and elevation. Also, a sight on a previously established survey point, taken to close a circuit.

**foreslope** The steep slope extending from the outer margin of an organic reef to an arbitrary depth of 10 fathoms.

**forest bed** (for'-est) An interglacial deposit containing soil and the woody remains of trees and other vegetation.

**form** 1. All the faces of a crystal that have a like position relative to the elements of symmetry. 2. *landform*.

**formal unit** (for'-mal) A stratigraphic unit that is defined and named in accordance with the rules of an established or conventional system of classification and nomenclature. The initial letter of each word in the name of a formal unit should be capitalized. Cf: *informal unit*.

**format** (for'-mat) Informal rock-stratigraphic unit bounded by marker horizons believed to be isochronous surfaces that can be traced across facies changes, particularly in the subsurface, and useful for correlation between areas where the stratigraphic section is divided into different formations that do not correspond in time value.

**formation** (for-ma'-tion) 1 A body of rock strata that consists dominantly of a certain lithologic type or combination of types. It is the fundamental *lithostratigraphic unit*. Formations may be combined into *groups* or subdivided into *members*. 2 A lithologically distinct mappable body of igneous or metamorphic rock. 3 An informal term applied by drillers to a sedimentary rock with certain drilling characteristics, e.g. 'cherty formation'. 4 A group of plant or animal *associations* that exist together because of closely similar life patterns, habits and climatic requirements. 5 A topographic feature differing conspicuously from adjacent features, e.g. a striking erosional form on the land surface. 6 A *speleothem*.

**formation factor** The ratio of the conductivity of an electrolyte to the conductivity of a rock saturated with that electrolyte. Syn. *resistivity factor*.

**formation water** Water present in a water-bearing formation under natural conditions, as opposed to introduced fluids, such as *drilling mud*. Cf. *connate water*.

**form contour** A topographic contour determined by stereoscopic study of aerial photographs without ground control or by other means not involving conventional surveying.

**form energy** The potentiality of a mineral to develop its own crystal form against the resistance of the surrounding solid medium.

**form genus** 1 A *taxon* primarily for convenience in classifying fossils of problematic relationship that are morphologically similar. 2 Informally, a genus containing several species with the same general morphology but suspected of having unrelated ancestors, also, a genus in a series of related genera that have resulted from the splitting-up of an old familiar genus.

**forsterite** (for'-ster-ite) A whitish or yellowish mineral of the olivine group,  $Mg_2SiO_4$ . It is isomorphous with fayalite and occurs chiefly in metamorphosed dolomites and limestones.

**fossa** (fos'sa) 1 A linear topographic depression on Mars, similar to a terrestrial graben. 2 A depression on the surface of a shell or bone for attachment of a muscle or ligament.

**fosse** (foss) 1 A long, narrow trough between the edge of a retreating glacier and the wall of its valley, or between the front of a moraine and its outwash plain. 2 A canal, ditch, or other long, narrow waterway.

**fossil** (fos'sil) n. Any remains, trace, or imprint of a plant or animal that has been preserved in the earth's crust since some past geologic or prehistoric time, loosely, any evidence of past life.—adj. 1 Said of any object that existed in the geologic past and of which there is still evidence, e.g. "fossil waterfall". 2 Applied to coal, oil, and natural gas, i.e. *fossil fuels*. 3 Loosely applied to persons or

equipment involved with the fossil fuels, e.g. "fossil engineer", "fossil generating plant."

**fossil assemblage** *assemblage*.

**fossil community** An *assemblage* in which the individuals lived in the same place where their fossils are found, are present in approximately the same numbers and sizes as when alive, and thus have experienced no post-mortem transport.

**fossil fuel** A general term for any hydrocarbon that may be used for fuel chiefly petroleum, natural gas, and coal.

**fossil ice** 1. Ice formed in, and remaining from, the geologically recent past. It is preserved in cold regions, such as the coastal plains of northern Siberia, where remains of Pleistocene ice have been found. 2. Relatively old *ground ice* in a permafrost region. Also, underground ice in a region where present-day temperatures are not low enough to create it.

**fossiliferous** (fos-sil-ĭf-er-ous) Containing fossils.

**fossilization** (fos'-sil-i-za'-tion) All processes involving the burial of a plant or animal in sediment and the eventual preservation of all, part, or a trace of it.

**fossil ore** An iron-bearing sedimentary deposit, e.g. *Clinton ore*, in which shell fragments have been replaced and cemented together by hematite and carbonate. Cf: *flaxseed ore*.

**fossil soil** *paleosol*.

**fossil wax** *ozocerite*.

**foundry sand** (found'-ry) Sand

used in making the forms in which molten metal is cast. Silica sand is the most common, but olivine, chromite, and other refractories are also used.

**fractional crystallization** (frac'-tion-al) 1. Crystallization from a magma, in which the early-formed crystals are prevented from equilibrating with the parent liquid, resulting in a series of residual liquids of more extreme composition than would have resulted from continuous reaction. Syn: *fractionation*. 2. Controlled precipitation from a saline solution of salts of different solubilities, as affected by varying temperatures or by the presence of other salts in solution.

**fractionation** (frac-tion-a'-tion) *fractional crystallization*.

**fracture** (frac'-ture) 1. The way in which a mineral breaks, other than along planes of cleavage, e.g. *conchoidal fracture*. 2. A crack, joint, fault, or other break in rocks. 3. Any rupture in fast ice or pack ice, from a few meters to many kilometers in length. 4. Deformation due to a momentary loss of cohesion or of resistance to differential stress and a release of stored elastic energy. Syn: *rupture*. Cf: *flow*.

**fracture cleavage** A type of cleavage that occurs in deformed but only slightly metamorphosed rocks and that is based on closely spaced, parallel joints and fractures.

**fracture porosity** Porosity resulting from the presence of opening

produced by the breaking or shattering of an otherwise less pervious rock.

**fracturing** (frac'-tur-ing) *hydraulic fracturing*.

**fragmental rock** (frag-men'-tal) 1. *clastic rock*. 2. *pyroclastic rock*. 3. *bioclastic rock*.

**fragmental texture** 1. A texture of sedimentary rocks, characterized by broken particles in surface contact; the term is used in distinction to a "crystalline" texture. 2. The texture of a *tuff* or other pyroclastic rock.

**framboid** (fram'-boid) A microscopic aggregate of pyrite grains in shale, often in spheroidal clusters resembling raspberry seeds. It was considered to be the result of colloidal processes but is now linked with the presence of organic materials. Adj: *framboidal*. Etymol: French *framboise*, "raspberry".

**framework** 1. The rigid arrangement created in a sediment by particles that support one another at their points of contact and are capable of maintaining open pore spaces. 2. A rigid, wave-resistant structure built by corals and other organisms, e.g. a *reef core*. 3. *tectonic framework*.

**franklinite** (frank'-lin-ite) An iron-black mineral of the magnetite series in the spinel group:  $(\text{Zn}, \text{Mn}^{+2}, \text{Fe}^{+2}) (\text{Fe}^{+3}, \text{Mn}^{+3})_2\text{O}_4$ . It is an ore of zinc.

**Franch process** A process for mining native sulfur, in which superheated water is forced into the deposits for the purpose of melt-

ing the sulfur. The molten sulfur is then pumped to the surface.

**frazil ice** (fra'-zil) A spongy, slushy aggregate of ice crystals, collected by adhesion or regelation and suspended in supercooled turbulent water, esp. common in a rapidly flowing stream, but also found in turbulent seawater.

**free** Said of a *native element*, e.g. free gold.

**free-air anomaly** A gravity anomaly calculated from a theoretical model and elevation above sea level, but without allowance for the attractive effect of topography and isostatic compensation.

**free-air correction** A correction for the elevation of a gravity measurement, required because the measurement was made at a different distance from the center of the earth than the datum.

**free energy** The capacity of a system to perform work, a change in free energy being measured by the maximum work obtainable from a given process.

**free period** The time for one complete swing of the seismograph mass when all damping is removed and the earth is quiet.

**freestone** 1. Any stone, esp. a thick-bedded sandstone, that breaks freely and can be cut and dressed in any direction without splitting. 2. Water containing little or no dissolved material.

**free water** 1. Water in soil or rock that is free to move in response to the pull of gravity. Syn: *gravitational water*. 2. Water that can be



removed from another substance, as in ore analysis, without changing the structure or composition of the substance.

**freezing interval** *crystallization interval*.

**frequency curve** (fre'-quen-cy) A curve that graphically represents a *frequency distribution*; e.g. a smooth line drawn on a histogram if the class interval is made smaller and the steps between several bars grow smaller.

**frequency distribution** The numerical or quantitative distribution of objects or material in a series of closely related classes. It is generally selected on the basis of some progressively variable physical character, such as the diameter of sedimentary particles.

**frequency domain** Measurements as a function of frequency or operations in which frequency is the variable, in contrast to the *time domain*.

**fresh water** Water with less than 0.2% dissolved salts, e.g., 2000 ppm. It may or may not be potable.

**freshwater limestone** A limestone formed by accumulation or precipitation in a freshwater lake or stream, or in a cave. It is often algal and sometimes nodular.

**friable** (fri'-a-ble) Said of a rock or mineral that is easily crumbled, e.g. a poorly cemented sandstone.

**fringing reef** An *organic reef* that is attached to or borders the shore of an island or continent, having a rough, tablelike surface that is exposed at low tide; it may be

more than 1 km wide, and its seaward edge slopes sharply down to the sea floor. There may be a shallow channel or lagoon between the reef and the adjacent mainland. Cf. *barrier reef*. Syn: *shore reef*.

**front** 1. The more or less linear slope of a mountain range that rises above a plain or plateau. 2. *ice front*. 3. A metamorphic zone of changing mineralization developed outward from an igneous mass. 4. The contact at the earth's surface between two different air masses, commonly cold and warm.

**front placoid** *orthopinacoid*.

**frost action** 1 The mechanical weathering process caused by repeated freezing and thawing of water in pores, cracks, and other openings, usually at the surface. It includes *congelifraction* and *congelifurbation*. 2. The resulting effects on materials and structures.—Syn: *freeze-thaw action*.

**frost crack** A nearly vertical fracture developed by thermal contraction in rock or frozen ground with appreciable ice content. Frost cracks commonly intersect to form polygonal patterns in plan view. Syn: *ice crack*; *contraction crack*.

**frost-crack polygon** A *nonsorted polygon* formed by intersecting *frost cracks*.

**frost creep** Soil creep resulting from frost action.

**frost-heaved mound** *stone ring*.

**frost heaving** The upward distortion of surface soils and struc-

tures, due to subsurface freezing of water and growth of ice masses; any upheaval of ground caused by freezing. Syn *frost heave*.

**frosting** 1 A ground-glass or mat surface on rounded mineral grains, esp of quartz. It may result from impacts of other grains during wind action, or from secondary deposition of fine silica.

2 The process that produces such a surface.

**frost line** 1 The maximum depth of frozen ground in areas where there is no permafrost, it may be expressed for a given winter, as the average of several winters, or as the greatest depth on record. 2 The bottom limit of permafrost.

3 The altitudinal limit below which frost never occurs, applied esp in tropical regions.

**frost mound** A general term for a knoll, hummock, or conical mound in a permafrost region, containing a core of ice, and representing a generally seasonal and localized upwarp of the land surface, caused by frost heaving and/or hydrostatic pressure of ground water. See also *pingo*. Syn *soil blister*.

**frost splitting** *conglafraction*.

**frost stirring** A syn of *conglutination* invol'g no mass movement.

**frost weathering** *conglafraction*.

**frost wedging** A type of *conglafraction* by which jointed rock is pried and dislodged by ice acting as a wedge.

**frozen ground** (fro'-zen) Ground that has a temperature below

freezing and generally contains a variable amount of water in the form of ice. Syn *gelisol*.

**frustule** (frus'-rule) The siliceous cell wall of a *diatom*, consisting of two halves. It is ornate, microscopic, and boxlike.

**fucoid** (fu'-coid [few'-coid]) n 1 Any indefinite trail-like or tunnel-like sedimentary structure identified as a *trace fossil* but not referred to a described genus. It was once considered to be the remains of the marine alga *Fucus*. See also *chondrite*. 2 A fossil of an alga, or resembling an alga, or the remains of a seaweed. 3 A seaweed of the order *Fucales* (brown algae) --ad). Pertaining to or resembling a fucoid. Syn *fucoidal*.

**fugitive constituent** (fu'-gu-tive) A substance that was originally present in a magma but was lost during crystallization, so that it does not commonly appear as a rock constituent. Syn *volatile component*.

**fulcrum** (ful'-crum) The intersection of the end of a recurved spit with the next succeeding stage in development of a compound spit.

**fulgurite** (ful'-gu-rite) An irregular glassy tube or crust produced by the fusion of loose sand by lightning, and found esp in dune areas. Etymol. Latin *fulgur*, "lightning".

**fuller's earth** A clay possessing a high adsorptive capacity, consisting largely of montmorillonite or palygorskite. It is extensively used as an adsorbent in refining

and decolorizing oils and fats, and is a natural bleaching agent

**fumarole** (fu'-ma-role) A hole or vent from which volcanic fumes or vapors issue See also *sol-fatara*

**fundamental strength** (fun-da-men-tal) The maximum stress that a substance can withstand, regardless of time, under given physical conditions without rupture or plastic deformation

**fungus** (fun-gus) An informal term for a member of the class Fungi, multicelled thallophytic plants that live on green plants Range, Precambrian to the present

**funnel pluton** A *pluton* having the general shape of an inverted cone and commonly consisting of layered gabbroic rocks

**furrow** 1 A linear depression produced by the removal of rock material, as by glacial action, e.g. a *groove* 2 A depressed part of the crust, of any size, with a distinct linear development Cf *welt*

**furrow cast** An impression on the lower side of a sedimentary layer of a furrow in the surface of the underlying bed

**fusain** (fu'-sain) An ingredient of banded coal characterized by silky luster, fibrous structure, friability, and black color It occurs in strands and patches and is soft and dirty unless mineralized Cf

*vitrain, clarain, durain* Syn *mineral charcoal*

**fusibility scale** (fu-si-bil'-i-ty) A temperature scale based on the fusibility of a standard group of minerals, with which other minerals may be compared stibnite, 550°C, chalcopyrite, 800°C, almandine garnet, 1050°C, actinolite, 1200°C orthoclase, 1300°C enstatite (bronzite), 1400°C, and quartz, infusible

**fusiform** (fu'-si-form) Spindle-shaped, narrowed both ways from a swollen middle

**fusionization** (fu-si-mi-za'-tion) A process of *exfoliation* in which fusain is formed Cf *incorporation, vitrification*

**fusion** (fu'-sion) 1 The process of liquefying a solid by addition of heat, melting 2 The unification of two or more substances, as by melting together 3 The combination of two light nuclei to form a heavier nucleus The reaction is accompanied by the release of a large amount of energy Cf *fission*

**fusulinid** (fu-su-lin'-id) Any foraminifer belonging to the suborder Fusulinina, family Fusulinidae, characterized by a multichambered calcareous test, commonly resembling the shape of a grain of wheat Range, Ordovician to Triassic Fusulinids are important guide fossils in the Pennsylvanian and Permian systems Syn *fusuline*.

**future ore** *possible ore*.

## G

**gabbro** A group of dark-colored, basic intrusive igneous rocks composed principally of labradorite or bytownite and augite, with or without olivine and orthopyroxene; also, any member of that group. It is the approximate intrusive equivalent of *basalt*. Apatite and magnetite or ilmenite are common accessory minerals. Gabbro grades into *monzonite* with increasing alkali-feldspar content.

**gabbroic layer** (gab-bro'-ic) *basaltic layer*.

**gage** In hydraulics, a device for measuring such factors as water-surface elevation, velocity of flow, water pressure, and precipitation.

**gage height** The water-surface elevation of a stream or lake referred to some arbitrary datum.

**gaging station** A particular site on a stream, canal, lake, or reservoir where systematic observations of gage height, discharge, or water quality (or any combination of these) are obtained.

**gal** A unit of acceleration, used in gravity measurements. One gal = 1 cm/sec<sup>2</sup>. The earth's normal gravity is 980 gal. The term was invented to honor the memory of Galileo. See also: *milligal*.

**galaxy** (gal'-ax-y) One of billions of large systems of stars, nebulae, star clusters, globular clusters, and interstellar matter that make up the universe. When the term is capitalized, it refers to the Milky

Way stellar system.

**Gale alidade** A light compact *alidade*, with a low pillar and a reflecting prism through which the ocular may be viewed from above. As used by geologists it is commonly equipped with the *Stebinger drum*. Syn: *explorer's alidade*.

**galena** (ga-le'-na) A gray metallic mineral, PbS. It has perfect cubic cleavage, is soft and very heavy, and is the principal ore of lead. Syn: *lead glance*.

**gallery** (gal'-ler-y) 1. A large, more or less horizontal passage in a cave. 2. A horizontal conduit constructed for the purpose of intercepting ground water.

**gamma** 1. The cgs unit of magnetic field intensity commonly used in magnetic exploration, equal to 10<sup>-5</sup> oersted. 2. In a biaxial crystal, the largest *index of refraction*; also, the angle between the *a* and *b* crystallographic axes. 3. Pertaining to a polymorphous modification of a mineral, specif. one that is stable at a temperature higher than those of its *alpha* and *beta* polymorphs, e.g. "gamma quartz".

**gamma radiation** Electromagnetic radiation from an atomic nucleus, often accompanying emission of *alpha particles* and *beta particles*. Cf: *gamma ray*.

**gamma ray** A photon from an atomic nucleus. See: *gamma radiation*.

**gamma-ray log** The *radioactivity log* curve of the intensity of broad-spectrum undifferentiated

natural gamma radiation emitted from the rocks in a cased or uncased borehole. It is used for correlation, and for distinguishing shales (which are usually richer in naturally radioactive elements) from sandstones, carbonates, and evaporites. Cf: *spectral gamma-ray log*.

**gangue (gang)** The valueless rock or mineral aggregates in an ore; that part of an ore that is not economically desirable but cannot be avoided in mining. It is separated from the ore minerals during concentration. Cf: *ore mineral*.

**ganister (gan'-is-ter)** 1. A hard, fine-grained quartzose sandstone or quartzite, used in the manufacture of silica brick. 2. In England, a highly siliceous *seat earth* of coal seams. 3. A mixture of ground quartz and fireclay used as a furnace lining.

**gap** 1. A break or opening in a mountain ridge, e.g. a *wind gap* or *col*; also, a gorge cut through such a ridge, e.g. a *water gap*. 2. In a fault, the horizontal component of separation measured parallel to the strike of the strata, with the faulted bed absent from the measured interval. 3. A break in the levee of a distributary stream. 4. A stratigraphic *break*. 5. A passage that connects two *abyssal plains* of different levels, through which clastic sediments are transported.

**garnet (gar'-net)** 1. A group of minerals of formula  $A_3B_2(Si-O_4)_3$ , where  $A = Ca, Mg, Fe^{+2}$ ,

and  $Mn^{+2}$ , and  $B = Al, Fe^{+3}, Mn^{+3}, V^{+3}$ , and  $Cr$ . 2. Any of the minerals of the garnet group, such as the end members almandine (Fe-Al), andradite (Ca-Fe), grossular (Ca-Al), pyrope (Mg-Al), spessartine (Mn-Al), uvarovite (Ca-Cr), and goldmanite (Ca-V).—Garnet has a vitreous luster, no cleavage, and a variety of colors, dark red being characteristic. It is most commonly found as euhedral isometric crystals in metamorphic rocks. Garnet is used as a semiprecious stone (the birthstone for January) and as an abrasive.

**garnierite (gar'-ni-er-ite)** A group name for various poorly defined hydrous magnesium-nickel silicates. It is an ore of nickel.

**gas natural gas**

**gas cap** Free gas occurring above oil in a reservoir, and present whenever more gas is available than will dissolve in the associated oil under existing pressure and temperature.

**gas-cap drive** Energy within an oil pool, supplied by expansion of an overlying volume of compressed free gas as well as by expansion of gas dissolved in the oil. Cf: *dissolved-gas drive*; *water drive*.

**gas coal** Bituminous coal that is suitable for the manufacture of flammable gas because it contains 33-38% volatile matter. Cf: *high-volatile bituminous coal*. See also: *coal gas*.

**gas-cut mud** Drilling mud returned from the bottom of a drill hole, characterized by a fluffy texture.

gas bubbles, and reduced density due to the retention of entrained natural gas rising from the strata traversed by the drill

**gas cycling** A secondary-recovery process involving injection into the reservoir of the gas or a portion of the gas produced with the oil

**gaseous transfer** (gas'-e-us) Separation from a magma of a gaseous phase that moves relative to the magma and releases dissolved substances, usually in the upper levels of the magma, when it enters an area of reduced pressure

**gas field** 1. A gas pool. 2. Two or more gas pools on a single geologic feature or otherwise closely related

**gash fractures** Small-scale tension fractures that occur at an angle to a fault and tend to remain open

**gasification** Production of fuel gas from coal

**gas-oil ratio** 1. The quantity of gas produced with the oil from an oil well, usually expressed as the number of cubic feet of gas per barrel of oil. Abbrev. GOR. 2. *reservoir gas-oil ratio*

**gas phase** That stage in a volcanic eruption that is characterized by the release of large amounts of volcanic gases

**gas pool** A subsurface accumulation of natural gas that will yield gas in economic quantities. Cf. *gas field*

**gas sand** A sand or sandstone containing a large quantity of natural gas.

**gas streaming** A process of mag-

matic differentiation in which the formation of a gas phase at a late stage in the crystallization results in partial expulsion, by the escaping gas bubbles, of residual liquid from the network of crystals

**gastrolith** (gas'-tro-lith) A highly polished, rounded stone or pebble from the stomach of some fossil vertebrates, esp. reptiles. Gastroliths are thought to have been used in grinding up food, but marine reptiles may have used them to increase body stability while in the water. Syn. *stomach stone*; *gizzard stone*

**gastropod** (gas'-tro-pod) Any mollusk belonging to the class Gastropoda, characterized by a distinct head with eyes and tentacles and, in most, by a single calcareous shell that is closed at the apex; sometimes spiralled, not chambered, and generally asymmetrical, e.g. a snail. Range, Upper Cambrian to present

**gas well** A well that is capable of producing natural gas or that produces chiefly natural gas. Some statutes define the term on the basis of the *gas-oil ratio*

**gather** (ga'-ther) A display of seismic input data, arranged so that all the traces corresponding to some criterion, such as shot-detector distance, are displayed side by side. It is used for checking corrections and evaluating the components of a *stack*

**gauss** The cgs unit for magnetic induction (flux density), the magnetic field conventionally symbolized by B. The field one cr. from

a straight wire carrying 5 amps is one gauss

**Gaussian curve** (Gauss'-i-an) *Normal distribution curve*

**geanticline** (ge-an'-ti-cline) 1 A mobile upwarping of the crust of the earth of regional extent. An *epi-geanticline*. 2 More specifically, an anticlinal structure that develops in tectonoclinal sediments owing to lateral compression.

Var. *geantiforme*

**Geiger counter** (Gai'-ger, Geiger-Mueller counter)

**Geiger-Mueller counter** An ionization chamber with its vacuum and applied potential so adjusted that a gamma ray or other ionizing particle through it causes a momentary current to flow. The surges of current can be amplified and counted so as to measure the intensity of radioactivity in the neighborhood of the chamber.

**gel** A jellylike material formed by coagulation of a colloidal dispersion. It is in a more solid form than sol.

**gelation** (ge-la'-tion) 1 The formation of a gel from a sol, as by coagulation or by precipitation from an electrolyte. 2 Setting.

**gelison** (gei'-sion) *frozen ore and*

**gem** A general term for any precious or semiprecious stone, especially when cut or polished for ornamental purposes.

**Gemology** (jen-i-'ol-og-ee) The science and study of gemstones including their source, description, origin, identification, grading, and appraisal. British spelling *gemmology*.

**gene** The fundamental unit governing the transmission of hereditary characteristics. Genes occur in a linear sequence on the chromosomes of a cell nucleus and are now thought to originate in the deoxyribonucleic acid (DNA) component in the chromosomes.

**gene complex** The system comprising all the interacting genetic factors of an organism.

**genera** The plural of *genus*.

**generic** (ge-ner'-ic) Pertaining to a genus.

**genetic** (ge-net'-ic) Pertaining to relationships due to a common origin or to features involving genes or gene complexes.

**genetic drift** Gradual change with time in the genetic composition of a continuing population resulting from the elimination of some genetic features and the appearance of others and appearing to be unrelated to the environmental benefits or detriments of the genes involved.

**genetics** The science that deals with the materials and processes of inheritable characteristics or features from generation to generation.

**genotype** (jen-o-'type) 1 *Type species*. 2 In genetics, the genetic constitution of an organism or a species in contrast to its observable physical characteristics.

**genus** (ge'-nus) A category in the hierarchy of plant and animal classification intermediate in rank between *family* and *species*. Adj. *generic*. Plural *genera*. Cf.

*subgenus.***geo-** A prefix meaning "earth"**geobotanical prospecting** (ge'-o-bo-tan'-i-cal) The visual study of plants and their distribution as indicators of soil composition and depth, bedrock lithology, the possibility of ore bodies, and groundwater conditions Cf *biogeochemical prospecting***geocentric** (ge-o-cen'-tric) Pertaining to, or measured from, the earth's center, having or relating to the earth as a center**geochemical anomaly** (ge-o-chem'-i-cal) A concentration of one or more elements in rock, soil, sediment, vegetation, or water that is markedly different from the normal concentration The term may also be applied to concentrations of hydrocarbons in soils**geochemical cycle** The sequence of stages in the migration of elements during geologic changes A major cycle proceeds from magma to igneous rock to sediments to sedimentary rocks to metamorphic rocks, and possibly through migmatites back to magma a minor or exogenic cycle proceeds from sediments to sedimentary rocks to weathered material and back to sediments again**geochemical exploration** The search for economic mineral or petroleum deposits by detection of abnormal concentrations of elements or hydrocarbons in surficial materials or organisms, usually by techniques that may be applied in the field Syn *geochemi-**cal prospecting.***geochemical facies** Any areal geological entity that is distinguishable on the basis of trace-element composition, radioactivity, or other geochemical property**geochemical prospecting** *geochemical exploration.***geochemistry** (ge-o-chem'-is-try) The study of the distribution and amounts of the chemical elements in minerals, ores, rocks, soils, water, and the atmosphere, and their circulation in nature, on the basis of the properties of their atoms and ions, also, the study of the distribution and abundance of isotopes, including problems of nuclear frequency and stability in the universe A major concern of geochemistry is the synoptic evaluation of the abundance of the elements in the earth's crust and in the major classes of rocks and minerals**geochron** (ge'-o-chron) An interval of geologic time corresponding to a *lithostratigraphic unit***geochronologic interval** (ge'-o-chron-o-log'-ic) The time span between two geologic events**geochronologic unit** *geologic-time unit.***geochronology** (ge-o-chro-nol'-o-gy) Study of time in relationship to the history of the earth, esp by the *absolute age* and *relative dating* systems developed for this purpose Cf *geochronometry* Syn *geologic chronology***geochronometry** (ge-o-chro-nom'-e-try) Measurement of *geologic time* by geochronologic methods.



esp. radiometric dating. Cf: *geochronology*.

**geocosmology** (ge'-o-cos-mol'-o-gy) The science that deals with the origin and geologic history of the earth, including its planetary attributes (shape, mass, density, physical fields, rotation, location of poles); the influence of the solar system, the galaxy, and the universe on the geologic development of the earth; and the material interaction between the earth and the universe. Syn: *geoastronomy*.

**geode** (ge'-ode) A hollow more or less globular body, up to 30 cm or more in diameter, found in certain limestones and volcanic rocks, and rarely in shales. Significant features include a thin outer layer of dense chalcedony; partial filling by inward-projecting crystals, generally quartz or calcite but sometimes barite or celestite; and evidence of growth by expansion. Unlike a *druse*, a geode is separable from the rock in which it occurs and its crystals are not of the same minerals as those of the enclosing rock. Cf: *vug*.

**geodesic line** (ge-o-des'-ic) A line of shortest distance between any two points on any mathematically defined surface.

**geodesy** (ge-od'-e-sy) 1. The science concerned with determination of the size and shape of the earth and the precise location of points on its surface. 2. The determination of the gravitational field of the earth and the study of temporal variations such as earth

tides, polar motion, and rotation.

**geodetic coordinates** (ge-o-det'-ic)

Quantities defining the horizontal position of a point on an ellipsoid of reference with respect to a specific geodetic *datum*, usually expressed as latitude and longitude. The elevation of a point is also a geodetic coordinate.

**geodetic surveying** Surveying in which account is taken of the figure and size of the earth and corrections are made for earth curvature; the applied science of geodesy. It is used where areas or distances involved are so great that results of desired accuracy and precision cannot be obtained by *plane surveying*. Syn: *geodetic engineering*.

**geodynamics** (ge'-o-dy-nam'-ics)

The branch of science that deals with the forces and processes of the earth's interior.

**Geodynamics Project** An international program of research (1971-1977) on the dynamics and dynamic history of the earth, with emphasis on deep-seated geological phenomena, esp. movement and deformations of the lithosphere.

**geofracture** (ge-o-frac'-ture) *geosuture*.

**geognosy** (gr-og'-no-sy) An 18th-century term for a science accounting for the origin, distribution, and sequence of minerals and rocks in the earth's crust. The term was superseded by *geology* as early ideas were abandoned. It has become restricted to absolute knowledge of the earth, as distinct

from the theoretical and speculative reasoning of geology.

**geographic center** (ge-o-graph'-ic)

The point on which an area on the earth's surface would balance if it were a plate of uniform thickness (i.e. the center of gravity of such a plate). The geographic center of the conterminous U.S. is in the eastern part of Smith County, Kansas (lat. 39°50'N, long. 98°35'W); the geographic center of North America is in Pierce County, N.D., a few miles west of Devils Lake.

**geographic cycle** *cycle of erosion.*

**geographic province** A large region all parts of which are characterized by similar geographic features Cf: *physiographic province*

**geography** (ge-og'-ra-phy) The study of all aspects of the earth's surface including its natural and political divisions, the distribution and differentiation of areas and, often, man in relationship to his environment. See also: *physical geography.*

**geohydrology** (ge'-o-hy-drol'-o-gy)

A term, often used interchangeably with *hydrogeology*, referring to the hydrologic or flow characteristics of subsurface waters. It is also used in reference to all hydrology on the earth without restriction to geologic aspects.

**geoid** (ge'-oid) The *figure of the earth* considered as a sea-level surface extended continuously through the continents. It is a theoretically continuous surface that is perpendicular at every point to the direction of gravity

(the plumb line). It is the surface of reference for astronomical observations and for geodetic leveling.

**geologese** (ge-ol-o-gese') Literary style or jargon peculiar to geologists.

**geologic** (ge-o-log'-ic) *geological.*

**geologic age** 1. The age of a fossil organism, or of a geologic event or feature, referred to the geologic time scale and expressed in terms of years (*absolute age*) or of comparison with the immediate surroundings (*relative age*); an age datable by geologic methods. 2. The term is also used to emphasize the long-past periods of time in geologic history, as distinct from present-day or historic times. See also: *age.*

**geological** (ge-o-log'-i-cal) Pertaining to geology. The choice between this term and *geologic* is optional, and may be made according to the sound of a spoken phrase or sentence. *Geological* is generally preferred in the names of surveys and societies, and in English and Canadian usage.

**geological oceanography** That aspect of the study of the ocean that deals with the ocean floor and the ocean-continent border, including submarine relief features, the geochemistry and petrology of the sediments and rocks of the ocean floor, and the influence of seawater and waves on the ocean bottom and its materials. Syn: *marine geology.*

**geologic-climate unit** An inferred widespread climatic episode de-

finer from a subdivision of Quaternary rocks, e.g. glaciation, interglaciation, stade, and interstade.

**geologic column** 1. A composite diagram that shows in columnar form the sequence of stratigraphic units of a given locality or region so arranged as to indicate their relations to the subdivisions of geologic time. See also: *columnar section*. 2. The sequence of rocks portrayed in such a column. Cf. *geologic section*.

**geologic hazard** A geologic condition or phenomenon that presents a risk or is a potential danger to life and property, either naturally occurring (e.g. earthquakes, volcanic eruptions) or man-made (e.g. ground subsidence, sea-water intrusion).

**geologic high** An oil-field term for a structure on which rocks occur at a higher position than in the surrounding area. Cf. *high*.

**geologic history** The history of the earth and its inhabitants throughout geologic time. It includes all conditions, processes, and events from the beginning of the planet to the present. Syn: *earth history*.

**geologic map** A map on which is recorded the distribution, nature, and age relationships of rock units and the occurrence of structural features.

**geologic province** A large region characterized by similar geologic history and development.

**geologic range** *stratigraphic range*.

**geologic record** The "documents" or "archives" of the history of the

earth, represented by bedrock, regolith, and the earth's morphology; the rocks and the accessible solid part of the earth. Also, the geologic history based on inferences from this record. See also: *stratigraphic record*.

**geologic thermometer** *geothermometer*.

**geologic thermometry** Measurement or estimation, by direct or indirect methods, of the temperatures at which geologic processes occur or have occurred in the past; e.g. the determination of the temperatures at which rocks and minerals crystallized within the earth's crust.

**geologic time** The time extending from the end of the formative period of the earth to the beginning of human history; the part of the earth's history that is recorded in the succession of rocks. The term implies extremely long duration or remoteness in the past, although no precise limits can be set.

**geologic time scale** An arbitrary chronological arrangement of geologic events, commonly presented in chart form with the oldest event and time unit at the bottom and the youngest at the top.

**geologic-time unit** A span of continuous time in geologic history, during which a corresponding *chronostratigraphic unit* was formed; a division of time distinguished on the basis of the rock record. Geologic-time units in order of decreasing magnitude are eon, era, period, epoch, and age.

Syn: *geochronologic unit; time unit.*

**geologist** (ge-ol'-o-gist) One who is trained in and works in any of the geological sciences.

**geology** (ge-ol'-o-gy) The study of the planet earth--the materials of which it is made, the processes that act on these materials, the products formed, and the history of the planet and its life forms since its origin. See also *earth science, geoscience, historical geology, physical geology.*

**geomagnetic** (ge'-o-mag-net'-ic) Pertaining to the magnetic field of the earth

**geomagnetic poles** The points of emergence at the earth's surface of the axis of the geocentric magnetic dipole that most closely approximates the earth's magnetic field. See also: *magnetic poles.*

**geomagnetic reversal** A change of the earth's magnetic field between *normal polarity* and *reversed polarity*. Syn: *magnetic polarity reversal; magnetic reversal.*

**geomagnetism** (ge-o-mag'-net-ism) The magnetic phenomena exhibited by the earth and its atmosphere; also, the study of such phenomena. Syn: *terrestrial magnetism.*

**geomechanics** (ge'-o-me-chan'-ics) That branch of geology dealing with the response of earth materials to the application of deforming forces and embracing the fundamentals of structural geology.

**geomorphic** (ge-o-mor'-phic) 1. Pertaining to the form of the earth or of its surface features; e.g. a

*geomorphic province.* 2. Pertaining to geomorphology; geomorphologic.

**geomorphic cycle** *cycle of erosion.*  
**geomorphogeny** (ge'-o-mor-phog'-e-ny) The part of geomorphology that deals with the origin and development of the earth's surface features.

**geomorphology** (ge'-o-mor-phol'-o-gy) 1 The science that treats the general configuration of the earth's surface; specif. the study of the classification, description, nature, origin, and development of landforms and their relationships to underlying structures, and the history of geologic changes as recorded by these surface features. 2. The features dealt with in, or a treatise on, geomorphology, e.g. the *geomorphology of Texas.*--Syn: *physiography.*

**geopetal** (ge-o-pet'-al) Pertaining to any rock feature, e.g. cross-bedding, that indicates the relation of top to bottom at the time of formation of the rock.

**geophone** (ge'-o-phone) A seismic detector, placed on or in the ground, that responds to ground motion at its point of location. Syn: *jug; pickup.*

**geophysical exploration** (ge-o-phys'-i-cal) The use of geophysical techniques--electric, gravity, magnetic, seismic, or thermal--in the search for economically valuable hydrocarbons, mineral deposits, or water supplies, or to gather information for engineering projects.

**geophysical survey** The use of one

or more geophysical techniques in *geophysical exploration*.

**geophysicist** (ge-o-phys'-i-cist)

One who studies the physical properties of the earth, or applies physical measurements to geological problems; a specialist in *geophysics*.

**geophysics** (ge-o-phys'-ics) Study of the earth by quantitative physical methods. There are numerous specialties within the field, e.g. seismology, tectonophysics, engineering geophysics.

**geopressured aquifer** (ge-o-pres'-sured) A term used for an aquifer, esp. in the Gulf Coast, in which fluid pressure exceeds normal hydrostatic pressure of 0.465 pound per square inch per foot of depth.

**geoscience** (ge-o-sci'-ence) 1 *geology* 2 *earth science*

**geosphere** (ge'-o-sphere) 1 The *lithosphere*. 2. The lithosphere, hydrosphere, and atmosphere combined. 3 Any of the so-called spheres or concentric layers of the earth

**geostatic pressure** (ge-o-stat'-ic) The vertical pressure at a point in the earth's crust caused by the weight of the overlying rock. Syn. *lithostatic pressure*; *rock pressure*.

**geosuture** (ge-o-su'-ture) 1. A boundary zone between contrasting tectonic units of the earth's crust; in many places a fault which probably extends through the entire thickness of the crust. 2. A place where two continents have come together.—Syn: *geofracture*.

**geosynclinal** (ge-o-syn'-cli-nal) n.

The original, now obsolete, term for *geosyncline*.—adj Pertaining to a geosyncline

**geosynclinal cycle** *orogenic cycle*

**geosynclinal prism** The load of sediments that accumulates, often to great thicknesses, in the downwarped part of a geosyncline, having a shape similar to that of a long, plano-convex prism whose convexity is at the floor. Cf. *clastic wedge*

**geosyncline** (ge-o-syn'-cline) A large troughlike or basinlike downwarping of the earth's crust, in which a thick succession of sedimentary and volcanic rocks accumulated. A geosyncline may form in part of a tectonic cycle in which orogeny follows. Cf: *mobile belt*. Ant: *geanticline*.

**geotechnics** (ge-o-tech'-nics) The application of scientific methods and engineering principles to the materials of the earth's crust for the solution of engineering problems. It embraces the fields of soil mechanics and rock mechanics, and many of the engineering aspects of geology, geophysics, and hydrology.

**geotectonic** (ge'-o-tec-ton'-ic) *tectonic*.

**geothermal** (ge-o-ther'-mal) Pertaining to the heat of the interior of the earth. Syn: *geothermic*.

**geothermal energy** Energy that can be extracted from the earth's internal heat.

**geothermal gradient** The rate of increase of temperature in the earth with depth. The gradient differs from place to place depending on

the heat flow in the region and the thermal conductivity of the rocks. The average geothermal gradient approximates  $25^{\circ}\text{C}/\text{km}$  of depth. **geothermal heat flow** The amount of heat energy leaving the earth per  $\text{cm}^2/\text{sec}$ , measured in calories/ $\text{cm}^2/\text{sec}$ . The mean heat flow for the earth is about  $15 \pm 0.15$  microcalories/ $\text{cm}^2/\text{sec}$ , or about 1.5 heat-flow units. Heat-flow measurements in igneous rocks have shown a linear correlation between heat production in rocks and surface heat flow. The heat production is due to the presence of uranium, potassium, and thorium. *Syn* **heat flow**

**geothermometer** (ge'-o-ther-mom-e-ter) A mineral or other feature of the rocks that forms within known thermal limits under particular conditions of pressure and composition and whose presence thus denotes a limit or a range for the temperature of formation of the enclosing rock. Examples are the filling temperatures of fluid inclusions, and the thermal discoloration of spores and conodonts. *Syn* **geologic thermometer**. **geothermometry** (ge'-o-ther-mom-e-try) 1 The study of the earth's heat, including its effect on physical and chemical processes. 2 Determination of the temperature of chemical equilibration of a rock, mineral, or fluid.

**geyser** (gev'-ser) A type of hot spring that intermittently erupts jets of hot water and steam, the result of ground water coming

into contact with rock hot enough to create steam under conditions preventing free circulation.

**geyser basin** A valley that contains numerous springs, geysers, and steaming fissures fed by the same ground-water flow.

**geyserite** (gey'-ser-ite) A *syn* of *siliceous sinter*, used esp. for the loose or compact incrustation of opaline silica deposited by precipitation from the waters of a geyser.

**geyser pipe** The narrow tube or well of a geyser extending downward from the surface pool.

**geyser pool** The comparatively shallow pool of heated water ordinarily contained in a crater or mound of *sinter* at the top of a geyser pipe.

**ghost** 1 A faint indication of a structure such as a crystal or fossil, more or less obliterated by diagenesis or replacement. 2 Seismic energy that travels upward from a profiling shot and then is reflected downward at the base of the weathering zone or the surface.

**giantism** (gi'-ant-ism) *gigantism*

**giant's kettle** A cylindrical hole bored in bedrock beneath a glacier by water falling through a deep *moulin* or by boulders rotating in the bed of a meltwater stream. *Syn* **glacial pothole**, *giant's cauldron*.

**gibbsite** (gibbs'-ite) A mineral,  $\text{Al}(\text{OH})_3$ . It is the principal constituent of many bauxites.

**gigantism** (gi'-gan-tism) In plants and animals, development to ab-

normally large size as a result of excessive growth

**gilsonite** One of the varieties of natural asphalt having a black color, brilliant luster, brown streak, and conchoidal fracture  
Syn *uintahite*.

**girdle (gr'-dle)** 1 In structural petrology, on an equal-area projection, a belt of concentration of points representing orientations of fabric elements 2 The outer edge of a fashioned gemstone, which is grasped by the setting or mounting 3 The region of overlap of the two valves of a diatom frustule 4 The marginal band encircling the shell plates of a chiton 5 In vertebrates, that part of the skeleton that connects front or hind limbs to the axial skeleton

**Gish-Rooney method** In electrical prospecting, the use of a double commutator to reverse periodically the direction of flow of current in both power and potential leads to eliminate *earth current* potentials

**gitology (gi-tol'-o-gy)** A term in creasingly in use, esp. in Europe, to describe the study of ore-deposit genesis in the broadest sense, including chemical, thermodynamic, petrological and economic disciplines Etymol French

**gizzard stone** *gastrolith*.

**glacial (gla'-chal)** 1 Pertaining to the activities of glaciers, or to the features or materials produced thereby 2 Pertaining to an ice age or a region of glaciation

**glacial boulder** A large rock fragment that has been transported by a glacier Cf *erratic*.

**glacial canyon** A deep valley eroded by a glacier, having a U-shaped cross profile and tributary gorges entering at levels well above the canyon bottom

**glacial cycle** 1 The ideal case of glaciation continuing so long under fixed climatic conditions that glacial erosion would be complete and replaced by normal erosion 2 A major global climatic oscillation of the order of 100,000 years, developed within an ice age

**glacial drift** *Drift* transported by glaciers or icebergs

**glacial epoch** Any part of geologic time, from Precambrian onward, in which glaciers covered a much larger total area than those of the present day, specif the latest of the glacial epochs, known as the Pleistocene Epoch Syn *glacial period* *ice age*

**glacial erosion** Reduction of the earth's surface as a result of grinding and scouring by glacier ice armed with rock fragments, together with the erosive action of meltwater streams

**glacial erratic** *erratic*.

**glacial geology** 1 The study of the geologic features and effects resulting from erosion and deposition by glaciers and ice sheets Cf *glaciology* 2 The features of a region that has undergone glaciation—Syn *glaciogeology*

**glacial groove** A furrow cut in bedrock by the abrading action of rock fragments embedded in a

glacier. It is larger and deeper than a *glacial striation*.

**glacial lake** 1. A lake partly or entirely fed by meltwater, or lying on glacier ice and due to differential melting. 2. A lake held in by a morainal dam. 3. A lake occupying a bedrock basin produced by glacial erosion, e.g. a *cirque lake*. 4. *kettle lake*. 5. *glacial lake*.

**glacial lobe** 1. A large tongue-like protrusion from the margin of an ice sheet. Cf: *outlet glacier*.

**glacial maximum** The time or position of the greatest advance of a glacier, or of glaciers (such as the greatest extent of Pleistocene glaciation). Ant: *glacial minimum*. Syn: *glaciation limit*.

**glacial mill moulin**.

**glacial minimum** The time or position of the greatest retreat of a glacier. Ant: *glacial maximum*.

**glacial plain** A plain formed by the direct action of glacier ice.

**glacial polish** The smooth, even surface produced on bedrock by the movement of abrasive-laden glacial ice.

**glacial recession** A decrease in the length of a glacier, i.e. a backward displacement of the terminus, owing to melting exceeding the rate of glacier flow. Syn: *glacial retreat*.

**glacial retreat** *glacial recession*.

**glacial scour** The eroding action of a glacier, including the removal of surficial material and the abrasion and polishing of the bedrock surface by rock fragments dragged along by the ice.

**glacial stairway** A glaciated valley whose floor rises in a series of irregular steplike benches.

**glacial striae** Glacial striations.

**glacial striation** One of a series of fine parallel straight lines cut on bedrock by rock fragments embedded at the base of a moving glacier, or cut on the rock fragments themselves. Cf: *glacial groove*. Syn: *glacial scratch*. Pl: *glacial striae*.

**glacial trough** A deep, steep-sided U-shaped valley leading down from a cirque, and excavated by an alpine glacier that has widened, deepened, and straightened a preglacial river valley; e.g. Yosemite Valley, Calif.\*

**glaciated** (gla'-ci-at-ed) Said of a formerly glacier-covered land surface, esp. one that has been modified by the action of a glacier or an ice sheet.

**glaciation** (gla-ci-a'-tion) 1. The formation, movement, and recession of glaciers or ice sheets. Syn: *glacierization*. 2. A collective term for the geological processes of glacial activity and the resulting effects on the earth's surface. 3. A climatic episode during which extensive glaciers developed, attained a maximum, and receded.

**glaciation limit** 1. The lowest altitude in a given locality at which glaciers can develop. 2. *glacial maximum*.

**glacier** (gla'-cier) 1. A large mass of ice formed on land by the compaction and recrystallization of snow, creeping downslope or out-



ward due to the stress of its own weight, and surviving from year to year. See also *alpine glacier*, *ice sheet*, *ice cap*. 2 A streamlike landform appearing or moving like a glacier, e.g. a *rock glacier*. —Etymol. French *glace*, "ice", from Latin *glacies*.

**glacier band** The appearance of one of a series of more or less extensive layers or lenses, on or within a glacier, that differ visibly in color or texture from the adjacent material. It may consist of ice, firn, snow, rock debris, dirt, organic matter, or any mixture of these materials.

**glacier burst** *glacier flood*.

**glacieret** (glä'-cier-et') A very small glacier on a mountain slope or in a cirque, as in the Sierra Nevada, Calif., a miniature alpine glacier. Cf. *cirque glacier*.

**glacier flood** A sudden release of meltwater from a glacier or glacier-dammed lake, formed by the melting of a drainage channel or by subglacial volcanic activity. It may result in a catastrophic flood. Syn. *glacier burst*.

**glacier flow** The slow downward or outward movement of the ice in a glacier, due to the force of gravity (*gravity flow*). Deformation within the ice, by intragranular gliding, grain-boundary migration, and recrystallization is involved, usually with sliding of the glacier on its bed. It is usually expressed in meters per day or year.

**glacier ice** Any ice that forms in or was once a part of a glacier in-

cluding land ice that is flowing or that shows evidence of having flowed, and glacier-derived ice floating in the sea.

**glacierization** (glä'-cier-i-zä'-tion) In British usage, approximately equivalent to *glaciation*, in the sense of the gradual covering of a land surface by glaciers or ice sheets.

**glacier lake** Water held in place by the damming of natural drainage by a glacier or ice sheet, as a lake ponded by glacier ice advancing across a valley, or occurring along the margin of a continental ice sheet. Cf. *proglacial lake*. Syn. *glacial lake*, *marginal lake*, *ice-dammed lake*.

**glacier milk** A stream of turbid, whitish meltwater containing *rock flour* in suspension.

**glacier table** A large block of rock supported by an *ice pedestal* that rises from the surface of a glacier. It occurs where the melting of the glacier is retarded by the insulation effect of the rock.

**glacier theory** The theory, first propounded about 1840 and now universally accepted, that the drift was deposited through the agency of glaciers and ice sheets moving slowly from higher to lower latitudes during the Pleistocene Epoch.

**glacier tongue** A long narrow extension of the lower part of a glacier.

**glacier well** *moulin*.

**glacier wind** A cold wind blowing off a glacier or out of ice caves in a glacier front.

**glaciofluvial** (glä'-ci-o-flu'-vi-al)

Pertaining to meltwater streams flowing from glaciers or to the deposits made by such streams.

Syn: *fluvio-glacial*.

**glacio-isostasy** (glä'-ci-o-i-sos'-tä-sy)

The state of hydrostatic equilibrium in the earth's crust as influenced by the weight of glacier ice.

**glaciolacustrine** (glä'-ci-o-la-cus'-trine)

Pertaining to, derived from, or deposited in glacial lakes; esp. said of landforms and deposits such as kame deltas and varved sediments.

**glaciology** (glä'-ci-ol'-o-gy)

The study of all aspects of snow and ice; the science that treats all processes associated with solid existing water.

**glance** A mineral that has a

splendent luster; e.g. chalcocite, or copper glance.

**glass** 1. A state of matter inter-

mediate between the close-packed, highly ordered array of a crystal, and the poorly packed, highly disordered array of a gas. Most glasses are supercooled liquids, i.e., metastable, but there is no break in the change in properties between the metastable and stable states. The distinction between glass and liquid is on the basis of viscosity 2. An amorphous product of the rapid cooling of a magma. It may constitute the whole rock (e.g. obsidian) or only part of a groundmass.

**glass sand** A sand that is suitable

for glassmaking because of its high silica content (93-99 + %)

and its low content of iron oxide, chromium, cobalt, and other colorants.

**glass sponge** Popular term for a class of Porifera (sponges) in which the skeletal framework consists of six-rayed spicules of silica. Syn: *hyalosponge*.

**glauconite** (gläw'-ber-ite) A brittle, light-colored, monoclinic mineral:  $\text{Na}_2\text{Ca}(\text{SO}_4)_2$ . It has a vitreous luster and saline taste, and occurs in saline residues.

**Glaucon's salt** (Gläw'-ber's) *mirabilite*.

**glauconite** (gläw'-co-nite) A green mineral, closely related to the micas and essentially a hydrous potassium iron silicate. It is common in sedimentary rocks from Cambrian to the present, and is abundant in *greensand*. It is an indicator of very slow sedimentation.

**glauconitic sandstone** (gläw'-co-nit'-ic) *greensand*.

**glaucophane** (gläw'-co-phane) A blue fibrous or prismatic monoclinic mineral of the amphibole group,  $\text{Na}_2(\text{Mg}, \text{Fe} + ^2)_3\text{Al}_2\text{Si}_8\text{O}_{22}(\text{OH})_2$ . It occurs only in crystalline schists resulting from regional metamorphism of sodium-rich igneous rocks.

**G layer** The seismic region of the earth's interior below 5160 km.; the inner core. It is a part of a classification of the earth's interior made up of layers A to G. Together with the F layer, it is the equivalent of the *lower core*.

**glide direction** The direction of gliding along *glide planes* in a

mineral.

**glide plane** A symmetry element in a crystal that relates parts on opposite sides by reflection plus translation parallel to the plane. The possible translation components associated with a glide plane must correspond to one half of a lattice translation. Syn: *translation plane*. Cf: *glide direction*.

**gliding** Slip or movement along certain lattice planes in crystalline substances, produced by deformation and characterized either as *translation gliding* or *twin gliding*.

**glint** An escarpment, particularly one produced by the outcrop of a dipping resistant formation. Etymol: Norwegian.

**glint lake** A lake formed along a *glint*, esp. a long, narrow glacial lake occupying a basin excavated in bedrock where a glacier is dammed by an escarpment.

**global tectonics** (glob'-al) Tectonics on a global scale, such as tectonic processes related to very large-scale movement of material within the earth; specif *new global tectonics*. Cf. *megatectonics*.

**globigerina ooze** (glo'-bi-g'er-i'-na [glo'-bi-j-a-ri'-na]) A deep-sea pelagic sediment containing at least 30% foraminiferal tests, predominantly of the genus *Globigerina*. It is calcareous, and a particular type of *foraminiferal ooze*.

**globular** (glob'-u-lar) *spherulitic*.

**globular projection** A map projection (neither conformal nor equal-area) representing a hemisphere

upon a plane parallel to its base, the point of projection being removed to a point outside of the opposite surface of the sphere. The equator and central meridian are straight lines intersecting at right angles; all other meridians and parallels are circular arcs. The projection is an arbitrary distribution of curves conveniently constructed; distance and directions can neither be measured nor plotted. It is commonly used in pairs in atlases.

**Glomar Challenger** A research ship specially designed to obtain long sediment cores by drilling into the ocean floor. It is used in the *Deep Sea Drilling Project*.

**glory hole** A large open pit from which ore is being or has been extracted.

**glossopterid** (glos-sop'-ter-id) n. The informal name for the fossil gymnosperm genus *Glossopteris* and its allies, whose foliage is common in the Permian of the Southern Hemisphere.—adj Pertaining to such a plant or plant assemblage

**glowing avalanche ash flow.**

**glowing cloud** *nuée ardente*.

**gneiss** (nice) A foliated rock formed by regional metamorphism, in which bands or lentules of granular minerals alternate with bands or lentules of minerals with flaky or elongate prismatic habit. Generally less than 50% of the minerals show preferred parallel orientation. Although gneiss is commonly feldspar- and quartz-rich, mineral composition

is not an essential factor in its definition. Varieties are distinguished by texture (e.g. augen gneiss), characteristic minerals (e.g. hornblende gneiss), or general composition and/or origin (e.g. granite gneiss). See also: *gneissic*; *gneissoid*.

**gneissic** (gneiss'-ic) Pertaining to the texture or structure typical of gneisses, with foliation that is more widely spaced, less marked, and often more discontinuous than that of a *schistose* texture or structure. Cf: *gneissoid*.

**gneissoid** (gneiss'-oid) Pertaining to a gneisslike structure or texture that is not the result of metamorphic processes, e.g. viscous magmatic flow forming a gneissoid granite. Cf: *gneissic*.

**gneissose** (gneiss'-ose) An ambiguous term, which may mean either *gneissic* or *gneissoid*. Its use is discouraged.

**goethite** (goe'-thite) A yellow, red, or brown mineral,  $\text{FeO(OH)}$ . It is the commonest constituent of much limonite, and occurs esp. as a weathering product in *gossans*.  
**gold** A soft yellow mineral, the native metallic element Au. Specific gravity of pure gold is 19.3. It is often naturally alloyed with silver, copper, or other metals, and is found as nuggets and grains in gravels, and in veins associated with quartz. See also: *electrum*.

**gold dust** Fine flakes or particles of gold, such as those obtained in placer mining.

**Goldschmidt's phase rule** The most famous of several modifica-

tions of the fundamental Gibbs phase rule. It assumes that two variables (taken as pressure and temperature) are fixed externally and that consequently the number of phases (minerals) in a system (rock) will not generally exceed the number of components. Syn: *mineralogical phase rule*. See also: *phase rule*.

**goldstone** A translucent, reddish-brown glass containing a multitude of tiny thin tetrahedra or hexagonal platelets of metallic copper, which exhibit bright reflections and produce a popular imitation of *aventurine*.

**Gondwana** (Gond-wa'-na) The late Paleozoic supercontinent of the Southern Hemisphere, named by Suess for the Gondwana System of India. The present-day southern continents are believed to be fragments that have separated from each other by *continental displacement*. Cf: *Laurasia*; *Pangea*. Var: *Gondwanaland*.

**goniatite** (go'-ni-a-tite) An ammonoid cephalopod typical of the Devonian and Carboniferous, characterized generally by a shell having sutures of angular appearance with eight undivided lobes.

**goniometer** (go-ni-om'-e-ter) An instrument for measuring the angles between crystal faces.

**GOR** *gas-oil ratio*.

**gorge** 1. A narrow, deep valley with nearly vertical rocky walls.

2. A narrow defile or passage between hills or mountains.—Etymol: French, "throat".

**gossan** (gos'-san) An iron-bearing

weathered product overlying a sulfide deposit. It is formed by the oxidation of sulfides and the leaching-out of the sulfur and most metals, leaving hydrated iron oxides and rarely sulfates. Syn: *iron hat*. Also spelled: *goz-zan*. Cf: *oxidized zone*.

**gouge** 1. A thin layer of soft, earthy *fault gouge* along the wall of a vein, which the miner can readily "gouge" out. 2. *crescentic gouge*.

**graben** (gra'-ben) An elongate, relatively depressed crustal unit or block that is bounded by faults on its long sides. It is a structural form, which may or may not be geomorphologically expressed as a *rift valley*. Etymol. German, "ditch". Cf: *horst*.

**grab sample** 1. A sample of rock or sediment taken more or less indiscriminately at any place. 2. A subaqueous sample of bottom sediment obtained by an instrument with movable jaws that close after being dropped to the bottom.

**grade** 1. The continuous descending curve, or longitudinal profile, of a stream channel, which everywhere is just steep enough to allow the stream to transport the load of sediment available to it. 2. A particular size range of particles of soil, sediment, or rock; a unit of a *grade scale*. 3. The relative quantity or percentage of ore-mineral content in an orebody. Syn: *tenor*. 4. *metamorphic grade*. 5. A classification of coal, based on degree of purity, i.e. quantity of ash left after burning.

Cf: *rank*. 6. A group of organisms, all at the same or a similar level of organization or advancement. 7. The degree of inclination of a road, railroad, embankment, or other structure, expressed as a ratio, fraction, or percent. It is synonymous with *gradient* as used in geomorphology.

**graded** 1. Said of a land surface on which erosion and deposition are so well balanced that a general slope of equilibrium is maintained. Syn: *at grade*. 2. A geologic term referring to a sediment or rock containing particles of essentially uniform size. Syn: *sorted*. 3. An engineering term for a soil or sediment consisting of particles of many sizes, or having a uniform distribution of particles from coarse to fine. This usage is essentially the opposite of the geological.

**graded bedding** A type of bedding in which each layer displays a gradual change in particle size, usually from coarse at the base to fine at the top. It may form under conditions in which the velocity of the prevailing current declined in a gradual manner, as by deposition from a single short-lived turbidity current.

**graded profile** *profile of equilibrium*.

**graded shoreline** A shoreline that has been straightened or simplified by the formation of barriers across embayments and by the cutting-back of headlands, with a vertical profile on which the energy of incoming waves is complete-

ly absorbed; a shoreline with a vertical *profile of equilibrium*.

**graded slope** The downstream gradient of a graded stream; it permits the most effective transport of load and is represented by the *profile of equilibrium*.

**graded stream** A stream in equilibrium, showing a balance between its transporting capacity and the amount of material supplied to it, and thus between degradation and aggradation in the stream channel

**grade level** The level attained by a stream when its whole course has been reduced to a uniform gradient, or when its longitudinal profile is a straight line

**grade scale** A systematic, arbitrary division of an essentially continuous range of particle sizes (of a soil, sediment, or rock) into a series of classes or grades for the purposes of standardization of terms and statistical analysis; it is usually logarithmic. Examples include: *Udden grade scale*; *Wentworth grade scale*; *Atterberg grade scale*; *Tyler Standard grade scale*; *Alling grade scale*

**gradient** (gra'-di-ent) 1. Degree of inclination of a part of the earth's surface; steepness of slope. It may be expressed as a ratio (of vertical to horizontal), fraction, percentage, or angle. 2. *hydraulic gradient*. 3. *stream gradient*. 4. In geophysics, the change in value of one variable with respect to another, e.g. gravity with respect to horizontal distance.

**grading** 1. Reduction of the land to

an equilibrium slope, e.g. erosion to base level by streams. 2. The formation of *graded bedding*.

**grading factor** The coefficient of sorting of a clastic sediment. Perfect sorting has a grading factor of 1.0.

**gradiometer** (gra-di-om'e-ter) Any instrument that is used to measure the *gradient* of a physical quantity, e.g. a device consisting of two magnetometers, one above the other, that measures the difference in the magnetic field at two locations.

**grahamite** (gra'-harg-ite) 1. A black asphaltite with a variable luster, black streak, high specific gravity, and high fixed-carbon content. 2. *mesosiderite*.

**grain** 1. A mineral or rock particle with a diameter of less than a few millimeters, such as a sand grain, also, a general term for particles of all sizes, as in the expressions "fine-grained" and "coarse-grained". 2. A single crystal or a separate particle of ice in snow or ice. 3. The linear arrangement of topographic features in a region, e.g. parallel ridges and valleys. 4. A quarrymen's term for a plane of parting in a metamorphic rock, e.g. slate, that is perpendicular to the flow cleavage; or for a direction of parting in massive rock, e.g. granite. Cf: *rift*

**grain growth** 1. The growth of a crystal, as from solution in open pore space or in a magma chamber; crystal growth. 2. The term has been applied to carbonate sediments, e.g. calcite mud or fi-

bers changing to calcite mosaic with a coarser texture; in this sense it is equivalent to *recrystallization*.

**grainstone** A mud-free grain-supported carbonate sedimentary rock. Cf: *packstone*; *mudstone*.

**granite** (gran'-ite) 1. A plutonic rock in which quartz makes up 10 to 50 percent of the felsic components and the alkali feldspar / total feldspar ratio is 65 to 90 percent. 2. Broadly applied, any holocrystalline quartz-bearing plutonic rock. 3. *commercial granite*. -- Etymol: Latin *granum*, "grain".

**granite gneiss** 1. A gneiss derived from a sedimentary or igneous rock and having the mineral composition of a granite. 2. A metamorphosed granite.

**granite porphyry** A hypabyssal rock differing from a *quartz porphyry* by the presence of sparse phenocrysts of mica, amphibole, or pyroxene in a medium- to fine-grained groundmass.

**granite tectonics** The study of the structural features, such as foliation, lineation, and faults, in plutonic rock masses, and the reconstruction of the movements that created them.

**granite wash** A driller's term for material eroded from outcrops of granitic rocks and redeposited to form a rock having approximately the same major mineral constituents as the original rock; e.g. an arkose consisting of granitic detritus.

**granitic** (gra-nit'-ic) 1. Pertaining to or composed of granite. 2. A

nonrecommended syn. of *granular*. Syn: *granitoid*.

**granitic layer** A syn. of *sial*, so named for its supposed petrologic composition. A layer is sometimes called "granitic layer" if it possesses the appropriate seismic velocity ( $\approx 6.0$  km/s), although nothing may be known about its composition. Cf: *basaltic layer*.

**granitization** (gran'-it-i-za'-tion)

An essentially metamorphic process or group of processes by which a solid rock is converted or transformed into a granitic rock by the entry and exit of material, without passing through a magmatic stage. The precise mechanism, frequency, and magnitude of the processes are still in dispute. Syn: *transformation*.

**granitoid** (gran'-it-oid) n. A granitic rock —adj. A syn. of *granitic*.

**granoblastic** (gran-o-blas'-tic) Pertaining to a *homeoblastic* type of texture in a nonschistose metamorphic rock in which recrystallization formed essentially equidimensional crystals with normally well sutured boundaries. Cf: *granuloblastic*.

**granodiorite** (gran-o-di'-o-rite) A group of coarse-grained plutonic rocks intermediate in composition between *quartz diorite* and *quartz monzonite* (U.S. usage), containing quartz, oligoclase or andesine, and potassium feldspar, with biotite, hornblende, or, more rarely, pyroxene, as the mafic components; also, any member of that group, the approximate intrusive equivalent of *rhyodacite*.

**granophyre** (gran'-o-phyre) 1. An irregular microscopic intergrowth of quartz and alkali feldspar. 2. A porphyritic extrusive rock characterized by a micrographic holocrystalline groundmass; or a fine-grained granitic rock having a micrographic texture. 3. A porphyritic rock of granitic composition characterized by a crystalline-granular groundmass.—Adj: *granophyric*.

**granophyric** (gran-o-phyr'-ic) 1. Of or pertaining to a *granophyre*. 2. A textural term applied to generally fine-grained intergrowths of quartz and alkali feldspar in igneous rocks.

**granular** (gran'-u-lar) 1. A textural term applied to holocrystalline rocks made up of grains of nearly the same size and in the range 2 to 10 mm. Metamorphic syn: *granoblastic*. 2. Also applied to a sedimentary rock made up of grains or granules.

**granular disintegration** A type of weathering consisting of grain-by-grain breakdown of rock masses composed of discrete mineral crystals, esp. of coarse-grained rocks (such as granite, gneiss, sandstone, and conglomerate), occurring in regions of great temperature extremes.

**granularity** (gran-u-lar'-i-ty) The quality, state, or property of being granular; specif. one of the component factors of the texture of a crystalline rock, including both grain size and grain-size distribution.

**granular texture** A rock texture re-

sulting from the aggregation of mineral grains of approximately equal size. The term may be applied to a sedimentary or metamorphic rock, but is esp. used to describe an equigranular, holocrystalline igneous rock whose particles range in diameter from 0.05 to 10 mm.

**granule** (gran'-ule) 1. A rock fragment larger than a very coarse sand grain and smaller than a pebble, having a diameter in the range of 2-4 mm. 2. A small, nonclastic (precipitated) grain, as of glauconite. 3. A grain of crushed and screened rock material used to form a coating on composition roofing.

**granulite** (gran'-u-lite) 1. A metamorphic rock consisting of even-sized, interlocking mineral grains. 2. A coarse granular metamorphic rock of the *granulite facies*. 3. An old term for sedimentary rock consisting of sand-size aggregates of nonclastic origin, e.g. a rock formed of oolitic grains.

**granulite facies** The metamorphic facies in which basic rocks are represented by diopside + hypersthene + plagioclase. It is typical of deep-seated regional dynamothermal metamorphism, at temperatures in excess of 650°C. Cf: *pyroxene-hornfels facies*.

**granuloblastic** (gran'-u-lo-blas'-tic) Said of a metamorphic homogenous texture in which mineral grains average 2 mm or less in diameter and largely lack rational faces but have straight or smooth-



ly curving grain boundaries and approximately polygonal shapes. Syn: *homogranular*; *even-grained*. **graphic** (graph'-ic) Said of the texture of an igneous rock that results from the regular intergrowth of quartz and feldspar crystals. The quartz commonly occupies triangular areas, producing the effect of cuneiform writing on a background of feldspar.

**graphic granite** A *pegmatite* characterized by graphic intergrowths of quartz and alkali feldspar.

**graphic log sample log.**

**graphite** (graph'-ite) A hexagonal mineral, a naturally occurring crystalline form of carbon dimorphous with diamond. It is opaque, soft, greasy to the touch, and iron black to steel gray; it occurs as crystals or as flakes or scales in veins or bedded masses or as disseminations in metamorphic rocks. Graphite conducts electricity well, and is immune to most acids and extremely refractory. It is used in lead pencils, paints, and crucibles, as a lubricant and an electrode, and in nuclear reactors. Syn: *plumbago*, *black lead*.

**graptolite** (grap'-to-lite) Any colonial marine organism belonging to the class Graptolithina, variously assigned to the phylum Coelenterata or to the Hemichordata, characterized by a tiny cup- or tube-shaped, highly resistant exoskeleton of organic composition, arranged with other individuals along one or more branch-

es to form a colony. Graptolites commonly occur in black shales. Range, Middle Cambrian to Carboniferous. Adj: *graptolithic*.

**graticule** (grat'-i-cule) 1. The network of lines representing meridians of longitude and parallels of latitude on a map or chart, on which the map or chart was drawn. Not to be confused with *grid*. 2. A template divided into blocks or cells that is used to integrate graphically a geophysical quantity such as gravity. 3. An accessory to an optical instrument such as a microscope, to aid in measuring the object under study, it is a thin disk bearing a scale which is superimposed on the object.

**grating** 1. In optical spectroscopy, equidistant and parallel lines that are used in producing spectra by diffraction. Syn: *diffraction grating*. 2. The gratelike pattern of lines observed in some serpentinized hornblende crystals, resulting from the occurrence of the initial alteration along cleavage cracks.

**gravel** (grav'-el) 1. An unconsolidated natural accumulation of rounded rock fragments, mostly of particles larger than sand (diameter greater than 2 mm), such as boulders, cobbles, pebbles, granules, or any combination of these; the unconsolidated equivalent of a *conglomerate*. 2. A popular term for detrital sediment along streams or beaches, composed chiefly of pebbles and sand. 3. An engineering term for

rounded fragments with diameters in the range of 4.76 mm to 76 mm (3 in.).

**gravel pack** 1. Gravel or coarse sand placed opposite an oil-producing sand in a well, to prevent or retard the movement of loose sand grains (along with the oil) into the well bore. It is usually forced through perforations under pressure. 2. Gravel or coarse sand placed opposite a water-producing zone in a well, to increase efficiency of the intake.

**gravimeter** (gra-vim'-e-ter) An instrument for measuring variations in the earth's gravitational field, generally by registering differences in the weight of a constant mass as the gravimeter is moved from place to place. Syn: *gravity meter*.

**gravimetry** (gra-vim'-e-try) The measurement of gravity or gravitational acceleration, especially as used in geophysics and geodesy.

**gravitational attraction** (grav-i-ta'-tion-al) See *law of universal gravitation*.

**gravitational constant** The constant  $\gamma$  in the law of universal gravitation: its value is  $6.670 \pm 0.005 \times 10^{-11}$  newton  $m^2/kg^2$ .

**gravitational gliding** *gravitational sliding*.

**gravitational separation** 1. The stratification of gas, oil, and water in a subsurface reservoir according to their specific gravities. 2. The separation of these fluids in a gravity separator after production.

**gravitational sliding** Downward

movement of rock masses on slopes by the force of gravity, e.g. along a thrust-fault plane. See also: *gravity tectonics*. Syn: *gravity sliding*; *gravitational gliding*; *écoulement*.

**gravitational water** *free water*.

**gravity** (grav'-i-ty) 1. The effect on any body in the universe of the attraction between it and all other bodies and of any centrifugal force that may act on the body because of its motion in an orbit. 2. The force exerted by the earth and its rotation on unit mass, or the acceleration imparted to a freely falling body in the absence of friction. 3. A general term for *API gravity* or *Baumé gravity*.

**gravity anomaly** The difference between the observed value of gravity at a point and the theoretically calculated value. Excess observed gravity is positive and deficient observed gravity is negative. Cf: *Bouguer anomaly*; *free-air anomaly*; *isostatic anomaly*.

**gravity compaction** Compaction of sediment resulting from overburden pressure.

**gravity fault** *normal fault*.

**gravity flow** Movement of glacier ice as a result of the inclination of the slope on which the glacier rests; *glacier flow*.

**gravity meter** *gravimeter*.

**gravity sliding** *gravitational sliding*.

**gravity survey** Measurements of the gravitational field at a series of different locations. The object is to associate variations with differences in the distribution of densi-

ties and hence of rock types. Gravity data usually are displayed as Bouguer or free-air anomaly maps.

**gravity tectonics** Tectonics in which the dominant propelling mechanism is believed to be downslope sliding under the influence of gravity.

**graywacke** (gray'-wacke) An old term, now generally applied to a dark gray firmly indurated coarse-grained sandstone that consists of poorly sorted angular to subangular grains of quartz and feldspar, with a variety of dark rock and mineral fragments, embedded in a compact clayey matrix having the general composition of slate and containing an abundance of very fine-grained illite, sericite, and chloritic minerals. Graywacke commonly exhibits graded bedding and is believed to have been deposited by submarine turbidity currents.

**greasy** Said of minerals that appear oily to the touch or to the sight.

**great circle** The line of intersection of the surface of a sphere and any plane which passes through the center of the sphere. The shortest distance between any two points on the surface is along the arc of a great circle connecting them.

**greenhouse effect** The heating of the earth's surface because outgoing long-wavelength terrestrial radiation is absorbed and re-emitted by the carbon dioxide and water vapor in the lower atmosphere and eventually returns to the

surface.

**green marble** *verd antique*.

**greensand** A sand or sandstone having a greenish color when fresh but an orange or yellow color when weathered, specif. an unconsolidated coastal-plain marine sediment consisting largely of dark green grains of glauconite, often mingled with clay or sand. The term is loosely applied to any glauconitic sediment. Syn: *glauconitic sand*; *glauconitic sandstone*.

**greenschist** A schistose metamorphic rock whose green color is due to the presence of chlorite, epidote, or actinolite. Cf: *greenschist*.

**greenschist facies** The metamorphic facies in which basic rocks are represented by albite + epidote + chlorite + actinolite. It includes the common products of low-grade regional metamorphism, and is believed to correspond to temperatures in the range 300°-500°C.

**greenstone** A field term for any compact dark-green altered or metamorphosed basic igneous rock that owes its color to chlorite, actinolite, or epidote. Cf: *greenschist*.

**greisen** (grai'-sen) A pneumatolytically altered granitic rock composed largely of quartz, mica, and topaz. The mica is usually muscovite or lepidolite. Tourmaline, fluorite, rutile, cassiterite, and wolframite are common accessory minerals.

**Grenville** A provincial series of the Precambrian of Canada and New

## York

**Grenville orogeny** A name that is widely used for a major plutonic, metamorphic, and deformational event during the Precambrian, dated radiometrically as between 880 and 1000 m.y. ago, which affected a broad province along the southeastern border of the Canadian Shield

**grid** 1 A network composed of two sets of uniformly spaced parallel lines usually intersecting at right angles and forming squares, superimposed on a map, chart, or aerial photograph to permit identification of ground locations by means of a system of coordinate and to facilitate computation of direction and distance. The term is frequently used to designate such a system superimposed on a map projection and usually carries the name of the projection, e.g. Lambert grid. Not to be confused with *graticule*. 2 A systematic array of points or lines, e.g. a rectangular pattern of pits or boreholes used in mineral exploration

**gridiron twinning** *crossed twinning*

**grinding pebbles** Pebbles, usually of chert or quartz, used for grinding in ball mills, etc. where contamination with iron must be avoided

**grit** 1 An imprecise term, most generally applied to a sandstone composed of angular particles, e.g. one suitable for use as millstones or grindstones, or to any sedimentary rock that looks or feels gritty. 2 Loose grains, natu-

ral or artificial, that are used for grinding and sharpening. Their size is designated by their *mesh* number

**groin** A low narrow jetty constructed of timber, stone, concrete, or steel, usually extending roughly perpendicular to the shoreline, designed to protect the shore from erosion by currents, tides, or waves, or to trap sand and littoral drift for the purpose of building up or making a beach. It may be permeable or impermeable

**groove cast** A rounded or sharp crested ridge a few millimeter high and many centimeters in length and width produced on the underside of a sandstone bed by the filling of a groove on the surface of an underlying mudstone. Cf. *drag mark*

**grossular** (gros-su-lar) The calcium-aluminum end member of the garnet group  $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_3$ . It often occurs in contact metamorphosed impure limestones. Syn. *grossularite*

**grossularite** (gros-su-lar-ite) *grossular*

**grotto** (grot'-to) A small cave or one of the rooms of a cave

**ground ice** 1 Lenses, wedges, or other bodies of ice enclosed in permanently frozen ground, often at considerable depth. Cf. *fossil ice*. 2 Ice of any origin that has been covered with soil. 3 Ice formed on the ground. 4 A disapproved syn. of *anchor ice*

**ground-ice mound** A *frost mound* or *pinga*.

**ground-ice wedge** *ice wedge*.

**ground magnetometer** A magnetometer primarily suitable for making static observations of magnetic-field intensity on the surface of the earth.

**groundmass** 1. The material between the phenocrysts in a porphyritic igneous rock. Syn: *matrix*. 2. A term sometimes used for the matrix of a sedimentary rock.

**ground moraine** An accumulation of till after it has been deposited or released from the ice during ablation, to form an extensive area of low relief devoid of linear elements.

**ground motion** The displacement of the ground due to the passage of elastic waves arising from earthquakes, explosions, seismic shots, and the like.

**ground roll** A seismic surface wave, generally of low frequency and velocity.

**ground water** 1. That part of the subsurface water that is in the zone of saturation, including underground streams. 2. Loosely, all subsurface water as distinct from surface water.—Syn: *subterranean water*; *phreatic water*; *underground water*.

**ground-water barrier** A natural or artificial obstacle, such as a dike or fault gouge, to the lateral movement of ground water. It is characterized by a marked difference in the level of the ground water on opposite sides.

**ground-water basin** 1. A subsurface structure having the charac-

ter of a basin with respect to the collection, retention, and outflow of water. 2. An aquifer or system of aquifers, whether basin-shaped or not, that has reasonably well defined boundaries and more or less definite areas of recharge and discharge. Cf: *artesian basin*.

**ground-water divide** A ridge in the *water table*, from which ground water moves away in both directions.

**ground-water flow** 1. The movement of water in the zone of saturation, whether naturally or artificially produced. 2. *ground-water runoff*.

**ground-water level** *water table*.

**ground-water reservoir** *aquifer*.

**ground-water runoff** The *runoff* that has entered the ground, become ground water, and been discharged into a stream channel. Cf: *delayed runoff*. Syn: *ground-water flow*.

**ground-water surface** *water table*.

**group** 1. The formal *lithostratigraphic unit* next in rank above *formation*. A group includes two or more associated formations with significant features in common. See also: *subgroup*; *super-group*. 2. A general term for an assemblage or sequence of igneous rocks or sedimentary beds.

**group velocity** The velocity with which seismic energy moves through a medium. Where velocity varies with frequency, individual phases will appear to travel at different *phase velocities*. See also: *dispersion*; *particle velocity*.

**grouting** The injection of cement slurry into fissured, jointed or permeable rocks in order to reduce their permeability or increase their strength.

**growth fabric** Orientation of fabric elements independent of the influences of stress and deformation, i.e. characteristic of the manner in which the rock was formed.

**growth fault** A fault in sedimentary rock that forms contemporaneously and continuously with deposition, so that the throw increases with depth and the strata of the downthrown side are thicker than the correlative strata of the upthrown side. Such a structure occurs in the Gulf Coast region. See also: *hinge-line fault; rollover*. Syn: *contemporaneous fault; depositional fault; flexure fault; Gulf Coast-type fault; slump fault*.

**growth ring** The layer of wood produced in a tree during its annual growth period. Growth rings can be analyzed for chronologic and climatic data based on number and relative size. Cf. *dendrochronology*. Syn: *tree ring*.

**growth twinning** Twinning resulting from change in lattice orientation during the growth of a crystal.

**grus** An accumulation of angular, coarse-grained fragments resulting from the granular disintegration of crystalline rocks (esp. granite) generally in an arid or semiarid region.

**Guadalupian** (Gua-da-lu'-pi-an) Lower series of the Upper Permi-

an of North America.

**guano** (gua'-no) 1. A phosphate or nitrate deposit formed by the leaching of bird excrement accumulated in arid regions, e.g. islands of the eastern Pacific Ocean and the West Indies. It is processed for use as a fertilizer. 2. Similar deposits of bat excrement, found in caves and worked for phosphate or nitrate, as in Malaya.

**guest** A mineral introduced into and usually replacing a pre-existent mineral or rock. Ant: *host*.

**guide fossil** Any fossil that has actual, potential, or supposed value in identifying the age of the strata in which it is found or in indicating the conditions under which it lived; a fossil used esp. as an index or guide in the local correlation of strata. Cf. *index fossil*.

**gulch** A term used esp. in the western U.S. for a narrow, deep ravine with steep sides.

**gulf** 1. A relatively large part of the ocean or sea extending far into the land, the largest of various forms of inlets of the sea. 2. A deep, narrow gorge or chasm. 3. A *sink-hole*, commonly containing water on its floor.

**Gulf Coast-type fault** *growth fault*. **Gulfian** (Gulf'-i-an) Upper Cretaceous of North America.

**gulf-type gravimeter** A gravity meter consisting of a mass suspended at the end of a spring, the latter so designed that its extension will cause the mass to rotate. By this means the linear displacement of the spring is converted into an an-

gular deflection which is more easily measured. The design also minimizes the sensitivity to seismic disturbances and the basic instrument is therefore well suited for underwater observations.

**gully 1.** A small channel produced by running water in earth or unconsolidated material, e.g. in soil on a bare slope. 2. A minor channel incised in a mud flat below the high-water level.

**gully erosion** Erosion of soil or soft rock by running water that forms distinct, narrow channels that usually carry water only during and immediately after heavy rains or following the melting of ice or snow. Cf: *sheet erosion*.

**gumbo** A term used locally in the U.S. for a clay soil that becomes sticky, impervious, and plastic when wet.

**gumbotil** (gum'-bo-til) A gray to dark-colored, leached, deoxidized clay representing the B horizon of fully mature soils, developed from profoundly weathered clay-rich till under conditions of low relief and poor subsurface drainage (as beneath broad, flat uplands). It consists chiefly of beidellite and/or illite, and may contain altered rock fragments originally mixed with the clay; it is very sticky and plastic when wet, extremely firm when dry.

**Glänaz** The oldest of the four classical glacial stages of Europe, sometimes called the First Glacial Stage. It is now known that there were earlier glaciations in the Pleistocene.

**gut 1.** A very narrow passage or channel connecting two bodies of water; e.g. a small creek in a marsh or tidal flat. 2. A tidal stream connecting two larger waterways.

**Gutenberg discontinuity** (Gu'-ten-berg) The seismic-velocity discontinuity at 2900 km, marking the mantle-core boundary, at which the velocities of *P* waves are reduced and *S* waves disappear. It probably reflects the change from a solid to a liquid phase and a change in composition.

**guyot** (guy-ot' [gee-o']) A flat-topped *seamount*.

**gymnosperm** (gym'-uo-sperm) A plant whose seeds are commonly in cones and never enclosed in an ovary. Examples include cycad, ginkgo, pine, fir, and spruce. Such plants range from the Late Devonian. Cf: *angiosperm*.

**gyprock** A rock composed chiefly of gypsum.

**gypsite** (gyp'-site) An earthy variety of gypsum containing dirt and sand, found only in arid regions as an efflorescent deposit occurring over the ledge outcrop of gypsum or of a gypsum-bearing stratum.

**gypsum** (gyp'-sum) A widely distributed mineral consisting of hydrous calcium sulfate:  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . It is the commonest sulfate mineral, and is frequently associated with halite and anhydrite in evaporites, forming thick, extensive beds, esp. in rocks of Permian and Triassic age. Gypsum is used mainly as a retarder in port-

land cement, and in making plaster of Paris. Etymol: Greek *gypsos*, "chalk" Cf. *gypsite*.

**gypsum flower** Curved, twisted crystal growths of gypsum, resembling flowers, attached to a cave wall

**gypsum plate** In a polarizing microscope, a plate of clear gypsum (selenite) that gives a first-order red interference color, it is used to determine optical sign with crystals or interference figures and to determine the position of vibra-

tion-plane traces in crystal plates

**gyre** A circular motion of water in each of the major ocean basins, centered on a subtropical high-pressure region; its movement is generated by convective flow of warm surface water poleward, by the deflective effect of the earth's rotation, and by the effects of prevailing winds. The water within each gyre turns clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere



# H

**habit 1** The characteristic crystal form or combination of forms of a mineral 2 The characteristic appearance of an organism, esp those aspects that most affect its mode of life

**habitat** (hab'-i-tat) The environment in which the life needs of a plant or animal are supplied

**hachure** (ha'-chure) *n* One of a series of short, straight, evenly spaced, parallel lines, drawn perpendicular to the contour lines on a topographic map, e.g. an inward-pointing "tick" trending downslope from a depression contour Etymol French Syn *hatch-ing, hachure* —*v* To shade with or show by hachures

**hackly** Showing jagged points in fracture

**hadal** (ha'-dal) Pertaining to the deepest oceanic environment specifically that of oceanic trenches, i.e., over 6.5 km in depth

**hade** In structural geology, the complement of the *dip*; the angle that a structural surface makes with the vertical, measured perpendicular to the strike. It is little used

**Haeckel's law recapitulation theory.**

**hairstone** A variety of clear crystalline quartz thickly penetrated with fibrous, threadlike, or acicular inclusions of other minerals, usually crystals of rutile or actinolite. See also: *Venus hair; sage-nite*. Syn: *needle stone*.

**half life** The time period in which half the initial number of atoms of a radioactive element disintegrate into atoms of the element into which they change directly

**halide** (hal'-ide) A mineral compound characterized by a halogen such as fluorine, chlorine, iodine, or bromine as the anion Halite, NaCl, is an example Syn *halogenide*

**halite** (hal'-ite) A mineral, NaCl It is native salt, occurring in massive, granular, compact, or cubic-crystalline forms Syn *common salt, rock salt*

**halloysite** (hal-loy'-site) 1 A clay mineral related to kaolinite and with essentially the same chemical composition,  $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 \cdot 2\text{H}_2\text{O}$  Crystals observed under the electron microscope are slender tubes The term has also been used for a nonhydrated variety 2 In Europe, a syn of *endellite* as used in the U.S. 3 A general term for all halloysite minerals (hydrated or nonhydrated) and for artificially prepared complexes

**halmyrolosis** (hal-my-rol'-y-sis) The geochemical reaction of sea water and sediments in an area of little or no sedimentation Examples include modification of clay minerals, and the formation of glauconite from feldspars and micas. Cf. *diagenesis*. Syn. *submarine weathering*.

**halo 1.** A circular or crescentic distribution pattern about the source or origin of a mineral, ore, mineral association, or petrographic feature. It is encountered princi-

pally in magnetic and geochemical surveys. Cf: *dispersion pattern*. 2. Discoloration of a mineral, viewed in thin section, in the form of a ring. Most haloes of this sort are caused by radiation damage by alpha particles emitted from uranium- and thorium-bearing mineral inclusions.

**hammada** (ham-ma'-da) A plateau in a desert region with a rocky surface denuded by wind erosion. Etymol: Arabic.

**hammock** A term applied in the southeastern U.S. to a *hummock* rising slightly above a plain or swamp, esp. an island of dense tropical undergrowth in the Florida Everglades.

**hand level** A small leveling instrument in which the spirit level is so mounted that the observer may view the bubble at the same time that he observes an object through the telescope. See also: *Abney hand level*; *Locke hand level*.

**hand specimen** A piece of rock trimmed to a convenient size for megascopic study and for preservation in a reference or study collection.

**hanging** Situated on steeply sloping ground (e.g. a *hanging glacier*) or on top of other ground (e.g. a *hanging wall*), or having a discordant junction (e.g. a *hanging valley*).

**hanging glacier** A glacier, generally small, protruding from a basin or niche on a mountainside above a cliff or very steep slope, from which ice may break off occasion-

ally and abruptly to form an ice avalanche.

**hanging side** *hanging wall*.

**hanging valley** 1. A tributary glacial valley whose mouth is high above the floor of the main valley, the discordance being due to the greater erosive power of the trunk glacier. 2. A tributary stream valley whose mouth is notably higher than the floor of the main valley, as a result of more rapid deepening of the latter. 3. A coastal valley whose lower end is a cliff above the shoreline.

**hanging wall** The overlying side of an orebody, fault, or mine working; esp. the wall rock above an inclined vein or fault. Syn: *hanging side*. Cf: *footwall*.

**hard coal** *anthracite*.

**hardness** 1. The resistance of a mineral to scratching; it is a property by which minerals may be described. See *Mohs scale*. 2. A property of *hard water*, primarily due to the presence of ions of calcium and magnesium, and generally expressed as parts per million (ppm) or milligrams per liter (mg/l).

**hardness scale** *Mohs scale*.

**hardpan** 1. A hard, impervious, often clayey layer of soil at or just below the surface, produced by cementation of soil particles by relatively insoluble materials such as silica, iron oxide, and organic matter. Cf: *iron pan*; *duricrust*; *claypan*. 2. A layer of partly cemented gravel encountered in the digging of a gold placer. 3. A cemented layer of sand or gravel en-

closed within till. 4. A popular term used loosely for any hard layer that is difficult to excavate or drill. 5. *caliche*.

**hard rock** 1. A term used loosely for igneous or metamorphic rock, as distinguished from sedimentary rock. 2. Rock that requires drilling and blasting for its economical removal. Cf: *soft rock*.

**hard-rock geology** A colloquial term for geology of igneous and metamorphic rocks, as opposed to *soft-rock geology*.

**hard water** Water that does not lather readily when used with soap, and that forms a scale in containers in which it is allowed to evaporate; water high in ions of calcium and magnesium. See also: *hardness*. Cf: *soft water*.

**Harker diagram variation diagram**

**harmonic folding** (*har-mon'-ic*) Folding in which the strata remain parallel or concentric, without structural discordances between them, and in which there are no sudden changes in the form of the folds at depth. Ant: *disharmonic folding*.

**harpolith** (*harp'-o-lith*) 1. A large, sickle-shaped igneous intrusion that was injected into previously deformed strata and later deformed with the host rock by horizontal stretching or orogenic forces. 2. Essentially a *phacolith* with a vertical axis.

**Hartmann's law** The statement that the acute angle between two sets of intersecting shear planes is

bisected by the axis of greatest principal stress, and the obtuse angle by the axis of least principal stress.

**harzburgite** (*harz'-burg-ite*) A *peridotite* composed chiefly of olivine and orthopyroxene.

**Hawaiian-type bomb** (*Ha-wai'-ian*) A type of *volcanic bomb* formed when a still-plastic clot of lava strikes the ground, so that its shape is controlled by impact, not by its flight through the air.

**Hawaiian-type eruption** A type of volcanic eruption in which great quantities of extremely fluid basaltic lava are poured out, mainly issuing in lava fountains from fissures on the flanks of a volcano. Explosive phenomena are rare, but much spatter and scoria are piled into cones and mounds along the vents. Characteristic of shield volcanoes. Cf: *Peléean-type eruption*; *Strombolian-type eruption*; *Vulcanian-type eruption*.

**HDR** *hot dry rock*.

**head** 1. *headland*. 2. The source, e.g. of a stream, or the upper or inner part e.g. the apex of a delta or the end of a lake opposite the outlet. 3. The upper bend of a fold or structural terrace Cf: *foot*. 4. The elevation to which water rises at a given point as a result of reservoir pressure. 5. The section of a *rip current* which has widened out seaward of the break. 1. **head erosion** *headward erosion*.

**headland** 1. A prominent projection of the land, generally with a cliff face, jutting out from the coast into a sea or lake. Syn: *head*;

*promontory.*

**headwall** A steep slope at the head of a valley; esp. the rock cliff at the back of a *cirque*.

**headward erosion** The lengthening of a young valley or gully by erosion at the valley head; it is accomplished by rainwash, gully-ing, spring sapping, and slumping. Syn: *head erosion; headwater erosion.*

**headwater erosion** *headward erosion.*

**head wave** A seismic wave traveling downward at the critical angle to a high-velocity layer, moving along the top of that layer, and later emerging at the critical angle.

**heat budget** 1. The amount of heat required to raise the water of a lake from its minimum winter temperature to its maximum summer temperature; it is usually expressed as gram calories of heat per square centimeter of lake surface. 2. The amount of heat received and lost by any system, such as a lake, a glacier, or the entire earth, during a specific period.

**heat capacity** That quantity of heat required to increase the temperature of a system by one degree at constant pressure and volume. It is usually expressed in calories per degree Celsius. Syn: *thermal capacity.*

**heat conductivity** *thermal conductivity.*

**heat content** *enthalpy.*

**heat flow** *geothermal heat flow.*

**heave** 1. An upward movement of

a surface caused by expansion, as from swelling clay, removal of overburden, or frost action. Cf. *frost heaving.* 2. *Creep* in mines.

3. The horizontal component of separation or displacement on a fault. Cf: *throw.*

**heaving shale** An incompetent or hydrating shale that runs, falls, swells, or squeezes into a borehole.

**heavy liquid** In analysis of minerals, a liquid of high density, such as *bromoform*, in which specific-gravity tests can be made, or in which mechanically mixed minerals can be separated.

**heavy mineral** 1. A detrital mineral in a sedimentary rock, having a specific gravity greater than about 2.85 and commonly making up less than 1% in most sands, e.g. magnetite, ilmenite, rutile, garnet. Cf: *light mineral.* 2. A rock-forming mineral with a specific gravity greater than 2.9, a mafic mineral. **heavy oil** Crude oil that has a low *API gravity* or *Baumé gravity*. Cf: *light oil.*

**heavy spar** *barite.*

**hectare** (hec'-tare) A metric unit of land area equal to 10,000 square meters, 100 ares, or 2.471 acres. Abbrev: ha.

**hectorite** (hec'-tor-ite) A clay mineral of the montmorillonite (smectite) group, containing magnesium and lithium.

**hedrocraton** (hed'-re-o-cra'-ton) A stable, long-lasting continental shield and platform.

**height** 1. The vertical distance above a datum, usually the earth's

surface, *elevation* above a given level or surface 2 An area that rises to a considerable degree above the surrounding country, the term is often used in the plural Also, the highest part of a ridge, plateau, or other upland

**height of instrument** A surveying term used in spirit leveling for the height of the line of sight of a leveling instrument above the adopted datum, in trigonometric leveling for the height of the center of the theodolite above the ground or station mark, in stadia surveying for the height of the center of the telescope of the transit or alidade above the ground or station mark, and in differential leveling for the elevation of the line of sight of the telescope at the leveling instrument when the instrument is level Abbrev. HI

**helictite** (he-lic'-tite) A curved twiglike cave deposit, usually of calcite, that grows at the free end by deposition from water emerging there from a nearly microscopic central canal

**hematite** (hem'-a-tite) A common iron mineral  $\alpha\text{-Fe}_2\text{O}_3$  It occurs in rhombohedral crystals, in reniform masses or fibrous aggregates, or in deep-red earthy forms Hematite is found in igneous, sedimentary, and metamorphic rocks, both as a primary constituent and as an alteration product It is the principal ore of iron See also *specularite* Syn *red ocher*  
**hemera** (hem'-er-a) The geologic-time unit corresponding to *acme-zone*, the time span of the acme or

greatest abundance, in a local section, of a taxonomic entity Also, the period of time during which a race of organisms is at the apex of its evolution Etymol. Greek, "day" Pl *hemerae* Adj *hemeral*

**Hemichordata** (Hem'-i-chor-da'-ta) A subdivision of the *Protochordata* or of the *Chordata* including animals with a pre-oral notochord and three primary coelom segments in the adult

**hemihedral** (hem-i he'-dral) Said of the *merohedral* crystal class (or classes) in a system, the general form of which has half the number of equivalent faces of the corresponding holohedral form Syn *hemisymmetrical*

**hemimorphic** (hem-i-mor'-phic) Said of a crystal that has *polar symmetry* so that its two ends have different forms

**hemimorphite** (hem-i-mor'-phite) An orthorhombic mineral  $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$  It is similar to *smithsonite*, is a common secondary mineral, and is an ore of zinc. Syn *calamine*

**hemipelagic deposit** (hem'-i-pe-lag'-ic) Deep-sea sediment in which more than 25% of the fraction coarser than 5 microns is of terrigenous, volcanogenic, and/or neritic origin Such deposits usually accumulate near the continental margin Cf *terrigenous deposit*, *pelagic deposit*

**herbivore** (her'-bi-vore) An organism that feeds on plants Adj *herbivorous* Cf *carnivore*

**Hercynian orogeny** (Her-cyn'-i-an)

The Late Paleozoic orogenic era of Europe, extending through the Carboniferous and Permian. It is synonymous with the *Variscan orogeny*.

**heredity** (he-red'-i-ty) All the qualities and potentialities that an individual has acquired genetically from its ancestors.

**herringbone cross-bedding** Cross-bedding that dips in different or opposite directions in alternating beds, forming a herringbone or chevron pattern when viewed in cross section. Syn: *chevron cross-bedding*; *zigzag cross-bedding*.

**herringbone texture** In mineral deposits, a pattern of alternating rows of parallel crystals, each row in a reverse direction from the adjacent one. It resembles the "herringbone" textile fabric.

**heteroblastic** (het'-er-o-blas'-tic) Pertaining to a type of *crystalloblastic* texture in a metamorphic rock in which the essential mineral constituents are of two or more distinct sizes. Cf: *homeoblastic*.

**heteroichthonous** (het'-er-och'-tho-nous) 1. Said of a transported rock or sediment, or one that was not formed in the place where it now occurs. Also, said of fossils removed by erosion from their original deposition site and re-embedded. Cf: *allochthonous*. 2. Said of a fauna or flora that is not indigenous.

**heterogeneous equilibrium** (het'-er-o-ge'-ne-ous) Equilibrium in a system consisting of more than one phase. Cf: *homogeneous equilibrium*.

**heterogranular** (het'-er-o-gran'-ular) 1. Said of the texture of a rock having crystals of significantly different sizes. 2. Said of a rock with such a texture. Ant: *homogranular*. Syn: *inequigranular*.

**heteromorphism** (het'-er-o-mor'-phism) The crystallization of two magmas of nearly identical chemical composition into different mineral aggregates as a result of different cooling histories.

**hexacoral** (hex-a-cor'-al) A solitary or colonial coral having skeletal septa in cycles of six. The group includes most post-Paleozoic and living corals. Range, Middle Triassic to the present. Syn: *scleractinian*.

**hexagonal system** (hex-ag'-o-nal) One of the six crystal systems, characterized by one unique axis of threefold or sixfold symmetry that is perpendicular and unequal in length to three identical axes that intersect at angles of 120°. This definition includes the *trigonal system*.

**hexahedron** (hex-a-he'-dron) A polyhedron of six equivalent faces, e.g. a cube or a rhombohedron. Adj: *hexahedral*.

**hexoctahedron** (hex'-oc-ta-he'-dron) An isometric crystal form of 48 equal triangular faces, each cutting the three crystallographic axes at different distances.

**HI** *height of instrument*.

**hiatus** (hi-a'-tus) 1 A break or interruption in the continuity of a stratigraphic record, such as the absence of rocks that would normally be present in a sequence but

were never deposited. 2. The lapse in time of such an episode of non-deposition. Cf: *lacuna*.

**high n.** A general term for such features as a crest, culmination, anticline, or dome. Cf: *low*. Syn: *structural high*.

**high-angle fault** A fault with a dip greater than 45°. Cf: *low-angle fault*.

**high-calcium limestone** A limestone that contains very little magnesium; specif. one in which the calcium-carbonate content is greater than 95%. Cf: *magnesian limestone*.

**high-energy environment** An aqueous sedimentary environment characterized by a high *energy level* and by turbulent action (such as that created by waves, currents, or surf) that prevents the settling and accumulation of fine-grained sediment; e.g. a beach or a river channel. Cf: *low-energy environment*.

**high-grade adj.** Said of an ore with a relatively high ore-mineral content. Cf: *low-grade*. —v. To steal or pilfer ore or gold, as from a mine by a miner.

**high-grading** 1. Theft of valuable ore or mineral specimens by employees in a mine. 2. Working a mine without plan or system, removing only the high-grade ore.

**highland** An elevated or mountainous tract or region. The term is often used in the plural in a proper name; e.g. the Highlands of Scotland

**high oblique** An *oblique* photograph that includes the horizon.

Cf: *low oblique*.

**high plain** An extensive area of comparatively level land not situated near sea level; e.g. the High Plains, a relatively undissected region of the U.S., extending along the eastern side of the Rocky Mountains at elevations above 600 m.

**high quartz** *beta quartz*.

**high-rank graywacke** A feldspathic graywacke, formed in eugeosynclines. Cf: *low-rank graywacke*.

**high-rank metamorphism** Metamorphism accomplished under conditions of high temperature and pressure. Cf: *low-rank metamorphism*; *metamorphic grade*.

**high-speed layer** A subsurface layer in which the speed of seismic-wave propagation is appreciably greater than that in the layer just above it.

**high tide** The tide at its highest; the maximum level reached during a tidal cycle.

**high-volatile bituminous coal** Bituminous coal that contains more than 31% volatile matter, analyzed on a dry, mineral-matter-free basis. It has 11,500 to more than 14,000 BTU/lb (on a moist, mineral-matter-free basis). Coals of the middle and higher BTU ranges commonly soften when heated and can be used in the manufacture of *coke*.

**hill** 1. A natural elevation of the land surface, rising rather prominently above the surrounding area, generally considered to be less than 300 m (1000 ft) from

base to summit; the distinction between a hill and a *mountain* is arbitrary and dependent on local usage. See also: *mound*. 2. A range or group of hills, or a region characterized by hills or by a highland. Term usually used in the plural; e.g. the Black Hills of South Dakota.

**hill creep** Slow downhill movement, on a steep hillside and under the influence of gravity, of soil and loose rock, it is an important factor in the wasting of hillsides during dissection. See also: *creep*. Syn: *hillside creep*.

**hillock** A small, low hill, a mound  
**hill shading** A method of showing relief on a map by simulating the appearance of sunlight and shadows, assuming an oblique light from the NW so that slopes facing south and east are shaded (the steeper slopes being darker), thereby giving a three-dimensional impression similar to that of a relief model. The method is widely used on topographic maps in association with contour lines. Syn: *relief shading*.

**Hilt's law** The generalization that, in a vertical succession at any point in a coal field, coal rank increases with depth.

**hinge** 1. The locus of maximum curvature or bending in a folded surface, usually a line. Syn: *hinge line*; *flexure*. 2. A collective term for the structures of the dorsal region of a bivalve shell that function during the opening and closing of the valves.

**hinge fault** A fault on which the

movement of one side hinges about an axis perpendicular to the fault plane; displacement increases with distance from the hinge. Cf: *scissor fault*. Syn: *rotational fault*; *pivotal fault*.

**hinge line** 1. *hinge*. 2. A line or boundary between a stable region and one undergoing upward or downward movement.

**hinterland** (hin'-ter-land) An area bordering an orogenic belt on the side away from the direction of overfolding and thrusting.

**histogram** (his'-to-gram) A vertical-bar graph representing a *frequency distribution*, in which the height of bars is proportional to frequency of occurrence within each class interval. Histograms are used to depict particle-size distribution in sediments.

**historical geology** (his-tor'-i-cal) A major branch of geology that is concerned with the evolution of the earth and its life forms from its origins to the present day. The study of historical geology therefore involves investigations into stratigraphy, paleontology, and geochronology, as well as the consideration of paleoenvironments, glacial periods, and plate-tectonic motions. It is complementary to *physical geology*.

**Histosol** (His'-to-sol) In U.S. Dept. of Agriculture soil taxonomy, a soil order characterized by being more than half organic in its upper 80 cm. Most Histosols are saturated or nearly saturated most of the year unless they have been artificially drained.



**H layer** In a forest soil, a layer of amorphous organic material below the litter and the partially decomposed *humus*.

**hogback** 1. Any ridge with a narrow summit and steep slopes of nearly equal inclination, specif a sharp-crested ridge formed by the outcropping edges of steeply inclined resistant rocks, and produced by differential erosion. Cf: *cuesta*. 2. A term applied in New England to a *drumlin* or *esker*.

**hog wallow** A faintly rolling land surface characterized by many low, coalescent or rounded mounds (such as *Mima mounds*) that are slightly higher than the basin-shaped depressions between them.

**hollow** 1. A low tract of land surrounded by hills or mountains; a small, sheltered valley or basin, esp. in a rugged area. 2. A landform represented by a depression, such as a cirque, cave, large sink, or blowout.

**Holmes' classification** A classification of igneous rocks based primarily on the degree of silica saturation, and secondarily on other aspects of the mineralogical composition.

**holoblast** (hol'-o-blast) A mineral crystal that is newly and completely formed during metamorphism.

**Holocene** (Hol'-o-cene) An epoch of the Quaternary period, from the end of the Pleistocene, approximately 8 thousand years ago, to the present time; also, the corresponding series of rocks and

deposits. When the Quaternary is designated as an era, the Holocene is considered to be a period. Syn: *Recent*.

**holocrystalline** (hol-o-crys'-tal-line) Said of the texture of an igneous rock composed entirely of crystals, i.e. having no glassy part. Also, said of a rock with such a texture.

**holohedral** (hol-o-he'-dral) Said of that crystal class having the maximum symmetry possible in each crystal system Cf: *merohedral*; *tetartohedral*. Syn: *holosymmetric*.

**holohyaline** (hol-o-hy'-a-line) Said of an igneous rock that is composed entirely of glass.

**holomictic lake** (hol-o-mic'-tic) A lake that undergoes a complete mixing of its waters during periods of circulation or *overtun*.

**holoplankton** (hol-o-plank'-ton) Organisms that live their complete life cycle in the floating state.

**holosome** (hol'-o-some) An intertongued chronostratigraphic unit that may be either depositional (comprising one or more holostromes) or hiatal (consisting of combined hiatuses).

**holostrome** (hol'-o-strome) A stratigraphic unit consisting of beds laid down in a complete transgressive-regressive sequence including strata that may later have been removed by erosion.

**holosymmetric** (hol'-o-sym-met'-ric) *holohedral*.

**holothuroid** (hol-o-thu'-roid) A member of the echinoderm class

**Holothuroidea** a free-living animal with an elongated, more or less cylindrical body, e.g. a sea cucumber

**holotype** (hol'-o-type) The one specimen or other element designated by the author as the nomenclatural type in describing a new species. As long as the holotype is extant, it automatically fixes the application of the name concerned Cf *lectotype*, *neotype*

**homeoblastic** (ho'-me-o-blas'-tic) Pertaining to a type of *crystalloblastic* texture in a metamorphic rock in which the essential mineral constituents are approximately of equal size Cf *heteroblastic*

**homeomorph** (ho'-me-o-morph) 1 A crystal that resembles another in crystal form and habit, but has a different chemical composition 2 An organism that closely resembles another, although the two have different ancestors

**homeomorphism** (ho'-me-o-mor'-phism) The characteristic of crystalline substances of dissimilar chemical composition to have similar crystal form and habit such crystals are known as *homeomorphs* Adj *homeomorphic*, *homeomorphous*

**homeomorphous** (ho'-me-o-mor'-phous) Adj of *homeomorphism*

**homeomorphy** (ho'-me-o-mor'-phy) The phenomenon in which species having superficial resemblance are unlike in structural details, general similarity but dissimilarity in detail. The term is sometimes used as a syn. of *convergent evolution*

**homeostasis** (ho-me-ost'-a-sis) The trend toward a relatively stable internal condition in the bodies of the higher animals as a result of a sequence of interacting physiologic processes e.g. the ability to maintain relatively constant body heat during widely varying external temperatures

**homoclinal shifting** (ho-mo-cli'-nal) *monoclinal shifting*

**homocline** (ho'-mo-cline) A structural condition in which rock strata dip uniformly in one direction, e.g. one limb of a fold or a tilted fault block Cf *monocline*

**homogeneous equilibrium** (ho-mo-ge'-ne-ous) Equilibrium in a system consisting of only one phase, typically liquid or gaseous Cf: *heterogeneous equilibrium*

**homogranular** (ho-mo-gran'-u-lar) 1 Said of the texture of a rock having crystals of the same or nearly the same size. 2 Said of a rock with such a texture. Ant *heterogranular* Syn *equigranular*, *even-grained*, *granuloblastic*

**homologue** (hom'-o-logue) An organism or part of an organism exhibiting homology Also spelled *homolog*

**homology** (ho-mol'-o-gy) 1 Similarity but not identity between parts of different organisms, as a result of evolutionary differentiation from the same or corresponding parts of a common ancestor. 2 Similarity of position, proportion, structure, etc. without restriction to common ancestry — Adj *homologous*

**homonym** (hom'-o-nym) Any one

of two or more identical names used to identify different organisms or objects

**homoplastic** (ho-mo-plas'-tic)

Having homoplasia

**homoplasia** (ho-mop'-la-sy)

Similarity or correspondence of parts or organs that developed as a result of convergence or parallelism, rather than from a common ancestry Cf *homology*  
A 1) *homoplastic*

**homopycnal inflow** (ho-mo-pyc'-

nal) Flowing water of the same density as the body of water it enters resulting in easy mixing  
Cf *hyperpycnal inflow* *hypopycnal inflow*

**homotaxial** (ho-mo-tax'-i-al)

Pertaining to, characterized by or exhibiting homotaxy e.g. said of rock-stratigraphic units or biostratigraphic units that have a similar order of arrangement in different locations but are not necessarily contemporaneous

**homotaxy** (ho-mo-tax'-y)

Similarity of serial arrangement, specifically taxonomic similarity between stratigraphic or fossil sequences in separate regions or the condition of strata characterized by similar fossils occupying corresponding positions in different vertical sequences, without connotation of similarity of age Etymol Greek Cf *chronotaxy*

**honeycomb coral** (hon'-ey-comb)

A compound coral that has prismatic corallites so arranged as to resemble the cells of a honeycomb

**honeycomb weathering** A type of

chemical weathering in which innumerable pits are produced on a rock exposure The pitted surface resembles an enlarged honeycomb and is characteristic of finely granular rocks, such as tufts and sandstones, in an arid region

**hoodoo** A column, pinnacle, or pillar of rock produced in a region of sporadic heavy rainfall by differential weathering or erosion of horizontal strata, facilitated by joints and by layers of varying hardness, and occurring in varied and often eccentric or grotesque forms Cf *pillar* Etymol African

**hook** A *spit* or narrow cape turned sharply landward at its outer end, so as to resemble a hook in plan view, a *recurved spit*

**Hooke's law** A statement of *elastic deformation*, that the strain is linearly proportional to the applied stress

**hopper crystal** A cubic crystal of salt in which the faces of the cube have grown more at the edges than in the center, giving each face a centrally depressed or hopper-shaped form

**horizon** (ho-ri'-zon) 1 An interface that indicates a particular position in a stratigraphic sequence. Technically it is a surface with no thickness, but in practice it is commonly a distinctive very thin bed. It is incorrectly used as a synonym of *zone*, as in "oil-producing horizon" 2 In surveying, one of several lines or planes used as reference for observation and measurement and referred generally to a

horizontal direction. 3. *soil horizon*.

**horizontal axis** (hor-i-zon'-tal) The axis about which the telescope of a theodolite or transit rotates when moved vertically.

**horizontal displacement** *strike slip*.

**horizontal fault** A fault with no dip. Cf. *vertical fault*.

**horizontal separation** In faulting, the distance between the two parts of a disrupted unit (e.g. bed, vein, or dike), measured in any specified horizontal direction. Cf. *vertical separation*.

**horizontal slip** In a fault, the horizontal component of the net slip. Cf. *vertical slip*.

**horn** A high pyramidal peak with steep sides formed by the intersecting walls of three or more cirques, e.g. the Matterhorn.

**hornblende** The commonest mineral of the amphibole group,  $(Ca, Na)_{2-3}(Mg, Fe^{+2}, Fe^{+3}, Al)_5(Al, Si)_8O_{22}(OH)_2$ . It has a variable composition, and may contain potassium and appreciable fluorine. Hornblende is commonly black, and occurs in distinct monoclinic crystals or in columnar, fibrous, or granular forms. It is a primary constituent of many acid and intermediate igneous rocks and less commonly of basic igneous rocks, and is a common metamorphic mineral. Etymol: German.

**hornblendite** (horn'-blend-ite) A plutonic rock composed essentially of hornblende.

**horn coral** *solitary coral*.

**hornfels** (horn'-fels) A fine-grained

rock composed of a mosaic of equidimensional grains without preferred orientation and typically formed by contact metamorphism. Porphyroblasts or relict phenocrysts may be present in the characteristically granoblastic matrix.

**hornfels facies** A loosely defined term used to denote the physical conditions involved, or the set of mineral assemblages produced, by thermal (contact) metamorphism at relatively shallow depths in the earth's crust.

**hornito** (hor-ni'-to [or-nee'-to]) A small mound built on the back of a lava flow (generally pahoehoe), formed by the gradual accumulation of clots of fluid lava ejected through an opening in the roof of an underlying lava tube. Etymol: Spanish. Syn: *dribble cone*.

**horse** 1. A displaced rock mass that has been caught between the walls of a fault. 2. A miner's term for a barren mass of country rock occurring within a vein. 3. A *horseback* in coal.

**horseback** 1. A *cutout* in a coal seam; a mass of floor material protruding upward into the coal; or a dikelike body of clay that fills a crevice in the coal bed. 2. A term used in New England for an *esker* or a *kame*.

**horseshoe lake** *oxbow lake*.

**horsetail ore** Ore in a series of small fissures that divide or fray from a major vein.

**horst** An elongate, relatively uplifted crustal unit or block that is bounded by faults on its long

sides. It is a structural form and may or may not be expressed geomorphologically. Etymol German Cf *graben*.

**host** A rock or mineral that is older than rocks or minerals introduced into it or formed within it, such as a *host rock*, or a large crystal with inclusions of smaller crystals of a different mineral species. Ant *ques*.

**host rock** A body of rock serving as a *host* for other rocks or for mineral deposits e.g. a pluton containing xenoliths, or any rock in which ore deposits occur.

**hot dry rock** A potential source of heat energy within the earth's crust: rocks at depths less than 10 km and at temperatures above 150°C. They are related to two types of heat source: igneous magmas and conduction from the earth's deeper interior. Abbrev HDR.

**hot spot** A volcanic center, 100 to 200 km across and persistent for at least a few tens of millions of years, that is thought to be the surface expression of a rising *plume* of hot mantle material. Hot spots are not linked with arcs, and may or may not be associated with oceanic ridges. Some 200 late Cenozoic hot spots have been identified.

**hot spring** A thermal spring whose water has a higher temperature than that of the human body (above 98°F).

**hourglass valley** 1 A valley whose pattern in plan view resembles an hourglass, e.g. one extending

without interruption across a former divide, toward which it narrows from both directions. 2 *wineglass valley*.

**Hudsonian orogeny** (Hud-son'-i-an) A time of plutonism, metamorphism, and deformation during the Precambrian in the Canadian Shield (especially in the Churchill, Bear, and Southern provinces), dated isotopically as between 1640 and 1820 m.y. ago.

**huérfano** (huer'-fa-no [ware-fah-no]) A term used in the SW US for a hill or mountain of older rock surrounded by later sedimentary material esp. a solitary eminence separated by erosion from the mass of which it once formed a part. Etymol Spanish *huérfano*, 'orphan'.

**humic** (hu'-mic) Pertaining to or derived from *humus*.

**humic acid** Black acidic organic matter extracted from soils, low-rank coals, and other decayed plant substances by alkalis. It is insoluble in acids and organic solvents.

**humidity** (hu mid'-i ty) The water-vapor content of the atmosphere.

**hummock** 1 A knoll or mound above a level surface e.g. a *hammock*. 2 A mound or pile of broken floating ice that has been forced upward by pressure, as in an ice field or floe. 3 A small knob of earth or turf in subpolar and alpine regions.

**hummocky moraine** An area of *knob-and-kettle topography* that may have been formed either along a live ice front or around

masses of stagnant ice

**humus** (hu'-mus) The generally dark, more or less stable part of the organic matter of the soil, so well decomposed that the original sources cannot be identified. The term is sometimes used incorrectly for the total organic matter of the soil, including relatively undecomposed material. Adj. *humic*

**Huronian** (Hu-to'-ni-an) A division of the Proterozoic of the Canadian Shield

**Huttonian** (Hut-to'-ni-an) Of or relating to James Hutton (1726-1797), Scottish geologist who advocated the theory of plutonism, introduced the concepts of uniformitarianism and the geologic cycle, and emphasized the indefinite length of geologic time

**Huygens' principle** (Huy'-gens') The statement that any particle excited by wave energy becomes a new point source of wave energy

**hyacinth** (hy'-a-cinth) A transparent red or brownish variety of zircon, sometimes used as a gem. The term has also been applied to several other orange-red minerals, including a variety of garnet

**hyaline** (hy'-a-line) Transparent like glass

**hyalite** (hy'-a-lite) A colorless variety of common opal that is sometimes clear as glass and sometimes translucent or whitish and that occurs as globular concretions (resembling drops of melted glass) or botryoidal crusts lining cavities or cracks in rocks

**hyalocrystalline** (hy'-a-lo-crys-

tal-line) A textural term applied to porphyritic rocks in which phenocrysts and groundmass are equal or nearly equal in volume, the ratio being between 5:3 and 3:5. Cf. *intersertal*

**hyalophitic** (hy'-a-lo-phit'-ic) Said of the texture of an igneous rock in which the last-formed interstitial material is glassy and makes up a proportion of the rock intermediate in texture between *hyalopilitic* and *hyaloclastic*. Cf. *intersertal*

**hyalopilitic** (hy'-a-lo-pilit'-ic) Said of the *intersertal* texture of a porphyritic igneous rock in which needlelike microlites are set in a glassy groundmass, the phenocrysts forming less than one eighth of the rock. Cf. *hyalophitic*

**hyalosponge** (hy'-a-lo-sponge) Any sponge belonging to the class Hyalospongiae, characterized chiefly by a skeleton composed of six-rayed siliceous spicules without calcium carbonate or spongin. Syn. *hexactinellid glass sponge*

**hybrid** (hy'-brid) n. 1. An individual having parents belonging to different species. 2. A rock mass whose chemical composition is the result of *assimilation* or *contamination*. -adj. Pertaining to a rock so formed

**hydatogenic** (hy'-da-to-gen'-ic) Said of a rock or mineral deposit formed by an aqueous agent, e.g. a mineral deposit in a vein from a magmatic solution, or an evaporite from a body of salt water. Cf. *pneumatogenic*

**hydrargillite** (hy-drar'-gil-lite)  
*gibbsite*.

**hydrate** (hy'-drate) n. A mineral compound that is produced by hydration, or one in which water is part of the chemical composition —v. To cause the incorporation of water into the chemical composition of a mineral.

**hydration** (hy-dra'-tion) The chemical combination of water with another substance.

**hydration shattering** The process of grain loosening and rock disintegration by the wedging pressure of water in films of varying thickness on silicate mineral surfaces. The water is drawn between the grains by electro-osmosis and exerts differential pressures up to 2000 kg/cm<sup>2</sup>, strong enough to loosen and separate the grains. Such a process may be significant in all climates, without the aid of freezing and thawing. It produces loosened and separated grains, the accumulation being *grus*.

**hydraulic action** (hy-drau'-lic) The mechanical loosening and removal of weakly resistant material solely by the action of flowing water, as by a stream impinging against the bank on the outside of a bend, or by waves pounding the base of a cliff.

**hydraulic conductivity permeability coefficient.**

**hydraulic fracturing** A general term, for which there are numerous trade or service names, for the fracturing of rock in an oil or gas reservoir by pumping in water (or other fluid) and sand (or other

granular material) under high pressure. The purpose is to produce artificial openings in the rock in order to increase permeability. The pressure opens cracks and bedding planes, and sand introduced into these serves to keep them open when the pressure is reduced. Syn: *fracturing, hydrofracturing*.

**hydraulic gradient** 1 In an aquifer, the rate of change of total head per unit of distance of flow at a given point and in a given direction. Cf. *pressure gradient*. 2 In a stream, the slope of a line representing the sum of kinetic and potential energy along the channel length. It is equal to the slope of the water surface in steady, uniform flow.

**hydraulic head** 1 The height of the free surface of a body of water above a given subsurface point. 2 The water level at a point upstream from a given point downstream.

**hydraulic jump** In fluid flow, a change in flow conditions accompanied by a stationary, abrupt turbulent rise in water level in the direction of flow. It is a type of stationary wave.

**hydraulic limestone** An impure limestone that contains silica and alumina (usually as clay) in varying proportions and that yields, upon calcining, a cement that will harden under water. See also: *cement rock*. Syn: *waterlime*.

**hydraulic mining** The extraction of desired earth material by means of strong jets of water, e.g. wash-

ing gold-bearing gravel into sluices, or phosphatic gravel or high-silica sand into sumps for removal

**hydraulic profile** A vertical section of the *potentiometric surface* of an aquifer

**hydraulic radius** The ratio of the area of a stream's cross section to its *wetted perimeter*

**hydraulics** The aspect of engineering that deals with the flow of water in rivers and canals, and the works and machinery for conducting or using it

**hydrobiotite** (hy-dro-bi'-o-tite) A clay mineral composed of mixed layers of biotite and vermiculite

**hydrocarbon** (hy-dro-car'-bon) Any organic compound, gaseous, liquid, or solid, consisting solely of carbon and hydrogen (Crude oil is essentially a complex mixture of hydrocarbons)

**hydrochemical prospecting** (hy-dro-chem'-i-cal) Prospecting guided by the trace-element content of ground and surface waters

**hydroclastic rock** (hy-dro-clas'-tic) 1 A clastic rock deposited by the agency of water 2 A rock broken by wave or current action 3 A volcanic rock broken or fragmented during chilling under water or ice

**hydroelectric power** (hy'-dro-elec'-tric) Electrical energy generated by means of a power generator coupled to a turbine through which water passes Cf. *waterpower*, *hydropower*, *white coal*

**hydroexplosion** (hy'-dro-ex-plo'-sion) A general term for a volcan-

ic explosion caused by the generation of steam from any body of water It includes phreatic, phreatomagmatic, submarine, and littoral explosions

**hydrofracturing** (hy-dro-frac'-tur-ing) *hydraulic fracturing*

**hydrogenesis** (hy-dro-gen'-e-sis) The natural condensation of moisture in the air spaces of surface soil or rock material

**hydrogen-ion concentration** (hy'-dro-gen-i'-on) *pH*

**hydrogen sulfide** A toxic, corrosive gas,  $H_2S$ , with a characteristic odor of rotten eggs It is emitted in the natural decomposition of organic matter and is present in much crude oil and natural gas  
**hydrogeochemistry** (hy'-dro-ge'-o-chem'-is-try) The chemistry of ground and surface waters, particularly the relationships between the chemical characteristics and quality of waters and the areal and regional geology Cf. *biogeochemistry*, *lithogeochemistry*  
**hydrogeology** (hy'-dro-ge-ol'-o-gy)

The science that deals with subsurface waters and with related geologic aspects of surface water It is commonly used interchangeably with *geohydrology*

**hydrograph** (hy'-dro-graph) A graph showing stage, flow, velocity, or other characteristics of water with respect to time A stream hydrograph commonly shows rate of flow, a ground-water hydrograph, water level or head

**hydrography** (hy-drog'-ra-phy) 1. The science that deals with the physical aspects of all waters on



the earth's surface, esp. the compilation of navigational charts of bodies of water 2 The body of facts encompassed by hydrography

**hydroolith** (hy'-dro-lith) 1 A rock that is chemically precipitated from solution in water, such as rock salt or gypsum 2 A rock that is relatively free from organic material 3 A *hydroclastic rock* consisting of carbonate fragments

**hydrologic budget** (hy-dro-log'-ic) An accounting of the inflow to, outflow from, and storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake, or reservoir the relationship between evaporation, precipitation, runoff, and the change in water storage Syn *water balance, water budget, hydrologic balance*

**hydrologic cycle** The constant circulation of water from the sea, through the atmosphere, to the land, and its eventual return to the atmosphere by way of transpiration and evaporation from the land and evaporation from the sea Syn *water cycle*

**hydrology** (hy-drol'-o-gy) 1 The science that deals with global water (both liquid and solid), its properties, circulation, and distribution, on and under the earth's surface and in the atmosphere, from the moment of its precipitation until it is returned to the atmosphere through evapotranspiration or is discharged into the ocean In recent years the scope of hydrology has been expanded to

include environmental and economic aspects 2 The sum of the factors studied in hydrology, the hydrology of an area or district  
**hydrolysis** (hy-drol'-y-sis) A decomposition reaction involving water In geology, it commonly indicates reaction between silicate minerals and either pure water or aqueous solution

**hydrolyzates** (hy-drol'-y-zates) Sediments characterized by elements that are readily hydrolyzed, concentrate in the fine-grained alteration products of primary rocks, and are thus abundant in clays, shales, and bauxites Hydrolyzate elements are aluminum and associated silicon, potassium, and sodium Also spelled *hydrolysates* Cf *resistates, oxidates, redurates, evaporates*

**hydrometamorphism** (hy-dro-met-a-mor-phism) The alteration of rocks by the addition, subtraction, or exchange of material brought or carried in solution by water, without the influence of high temperature or pressure

**hydrometer** (hy-drom'-e-ter) A tubular device made of glass with the lower end weighted, graduated in specific gravity, degrees API, or other units, designed to measure the specific gravity of a liquid by the depth to which the hydrometer sinks when immersed

**hydromica** (hy-dro-mi'-ca) *illite*

**hydromuscovite** (hy-dro-mus'-co-vite) A term applied loosely to any fine-grained, muscovite-like

clay mineral commonly but not always high in water content and deficient in potassium. It is probably an *illite*.

**hydrophilic** (hy-dro-phil'-ic) Having strong affinity for water; said of colloids that swell in water and are not easily coagulated.

**hydrophobic** (hy-dro-phob'-ic) Lacking strong affinity for water; said of colloids whose particles are not highly hydrated and coagulate easily.

**hydrophone** (hy'-dro-phone) A pressure-sensitive detector that responds to sound transmitted through water. It is used in marine seismic surveying, or as a seismometer in a well.

**hydroplasticity** (hy'-dro-plas-tic'-i-ty) Plasticity in sediments that results from the pressure of pore water.

**hydropower** (hy'-dro-pow-er) Literally, *waterpower*, but now generally considered a syn. of *hydroelectric power*.

**hydrosol** (hy'-dro-sol) A colloidal system in which water is the dispersion medium.

**hydrosphere** (hy'-dro-sphere) The waters of the earth, as distinguished from the rocks (*lithosphere*), living things (*biosphere*), and the air (*atmosphere*). It includes the waters of the ocean; all bodies of surface water on the continents; snow, ice, and glaciers; and liquid water, ice, and water vapor below the land surface. The definition may also include water vapor, clouds, and all forms of precipitation in the at-

mosphere.

**hydrostatic head** (hy-dro-stat'-ic)

The height of a vertical column of water, the weight of which, if of unit cross section, is equal to the hydrostatic pressure at a point.

**hydrostatic level** The level to which the water will rise in a well under its full pressure head. It defines the potentiometric surface.

**hydrostatic pressure** The pressure exerted by the water at any given point in a body of water at rest.

*Cf. confining pressure; geostatic pressure.*

**hydrostatic stress** A state of stress in which the normal stresses acting on any plane are equal and where shearing stresses do not exist.

**hydrothermal** (hy-dro-ther'-mal)

Of or pertaining to hot water, to the action of hot water, or to the products of this action, such as a mineral deposit precipitated from a hot aqueous solution; also, said of the solution itself. "Hydrothermal" is generally used for any hot water, but has been restricted by some to water of magmatic origin.

**hydrothermal alteration** Alteration of rocks or minerals by the reaction of hydrothermal water with pre-existing solid phases.

**hydrothermal deposit** A mineral deposit formed by precipitation of ore and gangue minerals in fractures, faults, breccia openings, or other spaces, by replacement or open-space filling, from watery fluids ranging in temperature from 50° to 700°C but generally below 400°C, and ranging in pres-

sure from 1 to 3 kilobars. The fluids are of diverse origin. Alteration of host rocks is common.

**hydrothermal stage** That stage in the cooling of a magma during which the residual fluid is strongly enriched in water and other volatiles. The exact limits of the stage are variously defined, in terms of phase assemblage, temperature, composition, and/or vapor pressure; most definitions consider it as the last stage of igneous activity, coming at a later time, and hence at a lower temperature than the *pegmatitic stage*.

**hydrothermal synthesis** Mineral synthesis in the presence of water at elevated temperatures.

**hydrothermal water** Subsurface water whose temperature is high enough to make it geologically or hydrologically significant, whether or not it is hotter than the rock containing it.

**hydrous** (hy-drous) Said of a mineral compound containing water.

**hydroxide** (hy-drox'-ide) A type of *oxide* characterized by the linkage of a metallic element or radical with the ion OH, such as brucite,  $Mg(OH)_2$ .

**hydroxylapatite** (hy-drox'-yl-ap-a-tite) 1 A rare mineral of the apatite group  $Ca_5(PO_4)_3(OH)$ . 2 An apatite mineral in which hydroxyl predominates over fluorine and chlorine.—Syn *hydroxapatite*.

**hydrozincite** (hy-dro-zinc'-ite) A mineral,  $Zn_5(CO_3)_2(OH)_6$ . It is a minor ore of zinc and is found in

the upper (oxidized) zones of zinc deposits as an alteration product of sphalerite. Syn *zinc bloom*, *calamine*.

**hydrozoan** (hy-dro-zo'-an) Any coelenterate belonging to the class Hydrozoa, characterized by forms that are usually colonial and more specialized than sponges. Range, Precambrian or Lower Cambrian to present.

**hygrometer** (hy-grom'-e-ter) An instrument for measuring the humidity of the air.

**hygroscopic** (hy-gro-scop'-ic) Having the property of readily absorbing moisture from the atmosphere.

**hygroscopic coefficient** The ratio of the weight of water that a completely dry mass of soil will absorb if in contact with a saturated atmosphere until equilibrium is reached to the weight of the dry soil mass, expressed as a percentage. See also *hygroscopic water*. Syn *hygroscopic capacity*.

**hygroscopic water** Moisture held in the soil that is in equilibrium with that in the atmosphere to which the soil is exposed. Syn *hygroscopic moisture*, *hygroscopic water*. See also *hygroscopic coefficient*.

**hypabyssal** (hyp-a-byss'-al) A general adjective applied to minor intrusions such as sills and dikes, and to the rocks that compose them, which have crystallized under conditions intermediate between plutonic and extrusive, being distinguished from these types in some cases by texture and in

others only by mode of occurrence.

**hyperfusible** (hy-per-fu'-si-ble) *n.* Any substance capable of lowering the melting ranges in end-stage magmatic fluids.

**hyperpycnal inflow** (hy-per-pyc'-nal) Flowing water that is denser than the body of water it enters, resulting in formation of a turbidity current. Cf: *hypopycnal inflow*; *homopycnal inflow*

**hypersaline** (hy-per-sal'-ine) Excessively saline; with a salinity substantially greater than that of normal sea water. Specif., having a salinity above the lowest at which halite can be precipitated.

**hypersthene** (hy'-per-sthene) A common rock-forming mineral of the orthopyroxene group, (Mg, Fe)SiO<sub>3</sub>. It is isomorphous with enstatite. It is an essential constituent of many igneous rocks.

**hypervelocity impact** (hy-per-veloc'-i-ty) The impact of a projectile onto a surface at a velocity such that the stress waves produced on contact are orders of magnitude greater than the static bulk compressive strength of the target material. The minimum required velocities vary for different materials, but are generally 1-10 km/sec, and about 4-5 km/sec for most crystalline rocks. In such an impact, the kinetic energy of the projectile is transferred to the target material in the form of intense shock waves, whose interactions with the surface produce a crater much larger in diameter than the projectile. Meteorites striking the

earth at speeds in excess of about 5 km/sec give examples of large hypervelocity impacts and produce correspondingly large craters.

**hypidiomorphic** (hy-pid'-i-o-mor'-phic) *subautomorphic*.

**hypidiotopic** (hy-pid'-i-o-top'-ic) Intermediate between *idiotopic* and *xenotopic*: esp. said of the fabric of a crystalline sedimentary rock in which the majority of the constituent crystals are subhedral. Also, said of the rock with such a fabric.

**hypocrystalline** (hy-po-crys'-tal-line) Said of the texture of an igneous rock that has crystalline components in a glassy groundmass, the ratio of crystals to glass being between 7:1 and 5:3. Syn: *merocrystalline*. Cf: *hypohyaline*.

**hypogene** (hy'-po-gene) 1 Said of a geologic process, and of its resultant features, occurring within and below the crust of the earth. Cf: *epigene*. Syn: *hypogenic*. 2 Said of a mineral deposit formed by ascending solutions; also, said of those solutions and of that environment. Cf: *supergene*; *mesogene*.

**hypohyaline** (hy-po-hy'-a-hne) Said of the texture of an igneous rock that has crystalline components in a glassy groundmass, with a ratio of crystals to glass between 3:5 and 1:7.

**hypolimnion** (hy-po-lim'-ni-on) The lowermost layer of water in a lake, characterized by an essentially uniform temperature (except during a *turnover*) that is

generally colder than elsewhere in the lake, and often by relatively stagnant or oxygen-poor water; specif the dense layer of water below the *metalimnion* in a thermally stratified lake Cf *epilimnion*

**hypopycnal inflow** (hy-po-pyc'-nal) Flowing water that is less dense than the body of water it enters, e.g. a river entering the ocean Cf *hyperpycnal inflow*; *homopycnal inflow*

**hypothermal** (hy-po-ther'-mal) Said of a hydrothermal mineral deposit formed at great depth and in the temperature range of 300°-500°C, also, said of that environment Cf *mesothermal*, *epithermal*, *telethermal*

**hypothesis** (hy-poth'-e-sis) A conception or proposition that is tentatively assumed, and then tested for validity by comparison with observed facts and by experimentation It is less firmly founded than a *theory*

**hypothetical resources** (hy-po-thet'-i-cal) Undiscovered mineral resources that we may reasonably expect to find in known mining

districts Cf *identified resources*; *speculative resources*

**hypotype** (hy'-po-type) A described or figured specimen used in extending or correcting knowledge of a *species*, or in other publications regarding it

**hypsographic curve** (hyp-so-graph'-ic) A cumulative-frequency profile representing the statistical distribution of the absolute or relative areas of the earth's solid surface (land and sea floor) at various elevations above, or depths below, a given datum, usually sea level

**hypometric** (hyp-so-met'-ic) Relating to elevation above a datum, usually sea level

**hysteresis** (hys-ter'-e-sis) 1 A lag in the return of an elastically deformed body to its original shape after the load has been removed. 2 The property that a rock is said to exhibit when its magnetization is nonreversible 3 A phase lag of dielectric displacement behind electric field intensity, due to energy dissipation in polarization processes

## I

**ice Water** in the solid state, specif the dense substance formed in nature by the freezing of liquid water, by the condensation of water vapor directly into ice crystals, or by the recrystallization or compaction of fallen snow Ice commonly occurs as hexagonal crystals, and in large masses is classed as a rock

**ice age** A loosely used syn of *glacial epoch*, or time of extensive glacial activity, specif the latest of the glacial epochs, also known as the Pleistocene Epoch

**iceberg** A large, massive piece of floating or stranded glacier ice of any shape, broken from the front of a glacier into a body of water An iceberg has the greater part of its mass ( $4/5$  to  $8/9$ ) below sea level It may reach a length of more than 80 km Syn *berg* Cf *fineberg*

**ice cap** A dome shaped or platelike cover of perennial ice and snow covering the summit area of a mountain mass so that no peaks emerge through it, or covering a flat landmass such as an Arctic island spreading outwards in all directions due to its own weight, and having an area of less than 50 000 sq km An ice cap is considerably smaller than an *ice sheet* Also spelled *icecap*

**ice cascade** *ice fall*

**ice cliff** Any vertical wall of ice, e g a very steep surface bounding a glacier or a mass of shelf ice

Syn. *ice face*

**ice-contact deposit** Stratified drift deposited in contact with melting glacier ice, such as an *esker*, a *kame*, a *kame terrace*, or a feature marked by numerous *kettles*

**ice-dammed lake** *glacier lake*

**iced firm** A mixture of ice and firm, firm permeated with meltwater and then refrozen

**ice face** *ice cliff*

**ice fall** That portion of a glacier that flows down a very steep gradient, developing a zone of crevasses Syn *ice cascade* Also spelled *icefall*

**ice field** An extensive area of interconnected glaciers in a mountain region, or of *pack ice* at sea

**ice foot** 1 The ice at the lower end or front of a glacier 2 A fringe of ice formed along a shoreline and attached to it, unmoved by tides, it is usually formed by the freezing of wind-driven spray, or of seawater during ebb tide

**ice front** 1 The floating vertical cliff forming the seaward edge of an ice shelf or other glacier that enters water, ranging in height from 2 to more than 50 m above sea level Syn *front* 2 The leading edge of a glacier

**ice island** A form of large tabular *iceberg* broken away from an ice shelf and found in the Arctic Ocean, having a thickness of 15 to 50 m and an area between a few thousand square meters and 500 sq km or even more The surface of an ice island is usually marked by broad, shallow, regular undulations that give it a ribbed ap-

pearance from the air.

**ice jam** 1. An accumulation of broken river ice lodged in a narrow part of the channel; it frequently produces local floods during a spring breakup. 2. An accumulation of large fragments of lake ice or sea ice thawed loose from the shore during early spring and later piled up on the shore by the wind, often exerting great pressures.

**Ice-land spar** A very pure and transparent variety of calcite, the best of which is obtained in Iceland. It cleaves easily and perfectly into rhombohedrons, which exhibit strong double refraction; it is an *optical calcite*. It occurs in vugs and cavities in volcanic rocks, and as nodules in residual clays in limestone regions.

**ice mountain** A popular term for a large iceberg.

**ice pack** *pack ice*.

**ice pan** A large, flat piece of sea ice, protruding several centimeters to a meter above the water, usually composed of winter ice up to one year old.

**ice pedestal** A pinnacle, column, or cone of ice projecting from the surface of a glacier and supporting, or formerly supporting, a large rock (*glacier table*) or mass of debris.

**ice plateau** 1. An ice-covered highland area whose upper surface is nearly level and whose sides slope steeply to lowlands or the ocean. 2. Any ice sheet with a level or gently rounded surface.

**ice pole** The approximate center of

the most consolidated part of the Arctic pack ice, and therefore a difficult point to reach by surface travel; it is near lat. 83°-84°N and long. 160°W. Syn: *pole of inaccessibility*.

**ice push** 1. The lateral pressure exerted by the expansion of shoreward-moving ice, esp. of lake ice. Syn: *ice shove*; *ice thrust*. 2. The ridge of material formed by an ice push. Syn: *lake rampart*; *ice-push ridge*.

**ice-push ridge** *lake rampart*.

**ice rafting** Transport of rock particles and other materials by floating ice.

**ice sheet** A *glacier* of considerable thickness and more than 50,000 sq km in area, forming a continuous cover of ice and snow over a land surface, spreading outward in all directions and not confined by the underlying topography; a *continental glacier*. Ice sheets are now confined to polar regions (as on Greenland and Antarctica), but during the Pleistocene Epoch they covered large parts of North America and northern Europe. See also: *land ice*. Cf. *ice cap*.

**ice shelf** A sheet of very thick ice, with a level or gently undulating surface, which is attached to the land along one side but most of which is afloat and bounded on the seaward side by a steep cliff (*ice front*) rising 2 to 50 m or more above sea level. Ice shelves have been formed along polar coasts (e.g. those of Antarctica, the Canadian Arctic islands, and Greenland), and they are general-

ly of great breadth, some of them extending several hundreds of kilometers seaward from the coastline. They are nourished by annual snow accumulation and by seaward extension of land glaciers; limited areas may be aground. Cf: *shelf ice*.

**ice tongue glacier tongue.**

**ice vein ice wedge.**

**ice wedge** Wedge-shaped, foliated ground ice produced in permafrost, occurring as a vertical or inclined sheet, dike, or vein tapering downward, and measuring from a few millimeters to as much as 6 m wide and from 1 m to as much as 30 m high. It originates by the growth of hoar frost or by the freezing of water in a narrow crack or fissure produced by thermal contraction of the permafrost. Syn: *ground-ice wedge*; *ice vein*.

**ice-wedge polygon** A large *nonsorted polygon* characterized by borders of intersecting ice wedges, found only in permafrost regions and formed by contraction of frozen ground. The fissured borders may be ridges or shallow troughs, and are underlain by ice wedges. Diameter: up to 150 m, averaging 10-40 m. In plan, the pattern tends to be three- to six-sided. Cf: *frost-crack polygon*.

**ichnofossil** (ich'-no-fos-sil) *trace fossil*.

**ichnology** (ich-nol'-o-gy) The study of *trace fossils*; esp. of fossil tracks.

**ichor** (i'-chor) A fluid thought to be responsible for such processes

as granitization. Originally the term carried the connotation of derivation from a magma. Syn: *residual liquid*.

**ichthyosaur** (ich'-thy-o-saur) A reptile of uncertain ancestry but of porpoiselike or sharklike body form as adaptation for life in the sea. Range, Middle Triassic to Upper Cretaceous.

**icicle** (i'-ci-cle) A pendant, somewhat conical, shaft of ice formed by the freezing of dripping water.

**Iddings' classification** A classification of igneous rocks proposed in 1913 by J. P. Iddings, in which the mineralogical classifications of Harry Rosenbusch and Ferdinand Zirkel are correlated with the C.I.P.W. or norm classification system.

**ideal cyclothem** A theoretical *cyclothem* that represents, in a given region and within a given stratigraphic interval, the optimum succession of deposits during a complete sedimentary cycle. It is constructed from theoretical considerations and from accumulated data from modern environments and experimental evidence. For example, an ideal cyclothem of ten members for western Illinois consists of the following sequence in descending order: (10) marine shale with ironstone concretions; (9) clean marine limestone; (8) black laminated shale with limestone concretions or layers; (7) impure, lenticular, fine-grained marine limestone; (6) gray marine shale with pyritic nodules; (5) coal; (4) underclay; (3) freshwa-



ter, usually nonfossiliferous, limestone; (2) sandy shale; and (1) fine-grained micaceous sandstone, locally unconformable on underlying beds.

**identified resources** (i-den'-ti-fied) Specific bodies of mineral-bearing rock whose existence and location are known. They may or may not be evaluated as to extent and grade. Identified resources include *reserves* and *identified subeconomic resources*. Cf: *hypothetical resources*; *speculative resources*.

**identified subeconomic resources** Mineral resources that are not *reserves*, but that may become reserves as a result of changes in economic and legal conditions. Syn. *conditional resources*. See also: *identified resources*.

**idioblast** (id'-i-o-blast) A mineral constituent of a metamorphic rock formed by recrystallization and bounded by its own crystal faces. It is a type of *crystalloblast*. Cf: *hypidioblast*; *xenoblast*.

**idioblastic** (id'-i-o-blas'-tic) Pertaining to an *idioblast* of a metamorphic rock. It is analogous to the term *automorphic* in igneous rocks. Cf: *hypidioblastic*.

**idiogeosyncline** (id'-i-o-ge'-o-syn'-cline) A type of late-cycle geosyncline between stable and mobile areas of the crust, the sediments of which are only weakly folded, such as the marginal basins of the East Indian island arc. Cf: *parageosyncline*.

**idiomorphic** (id'-i-o-mor'-phic) *automorphic*.

**idiotopic** (id'-i-o-top'-ic) Said of the fabric of a crystalline sedimentary rock, e.g. an evaporite or a recrystallized limestone, in which the majority of the constituent crystals are euhedral. Also, said of the rock with such a fabric. Cf: *xenotopic*; *hypidiotopic*.

**idocrase** (i'-do-crase) *vesuvianite*.

**igneous** (ig'-ne-ous) Said of a rock or mineral that solidified from molten or partly molten material, i.e. from a magma; also, applied to processes related to the formation of such rocks. Igneous rocks constitute one of the three main classes into which rocks are divided, the others being metamorphic and sedimentary. Etymol: Latin *ignis*, "fire".

**igneous breccia** 1. A breccia that is composed of fragments of igneous rock. 2. Any breccia produced by igneous processes, e.g. volcanic breccia, intrusion breccia.

**igneous complex** An assemblage of intimately associated and roughly contemporaneous igneous rocks differing in form or in petrographic type; it may consist of plutonic rocks, volcanic rocks, or both.

**igneous emanations** See *magmatic emanations*; *volcanic emanations*.

**igneous facies** A part of a body of igneous rock that differs in structure, texture, or composition from the typical rock of the body, e.g. a porphyritic facies of a granite. See also: *facies*.

**igneous-rock series** A group of related igneous rocks of the same general type of occurrence (plutonic, hypabyssal, or volcanic),

having in common certain mineralogical or textural features and exhibiting a continuous variation from one extremity of such a series to the other *Syn rock series*.

**ignimbrite** (ig-nim'-brite) The rock formed by the widespread deposition and consolidation of ash flows and nuées ardentes. The term includes *welded tuff* and nonwelded but recrystallized ash flows. See also *tufflava*.

**Illinoisan** (Il-li-nois'-an) Pertaining to the classical third glacial stage of the Pleistocene Epoch in North America. See also *Riss*. Also spelled *Illinoian*.

**illite** (il'-lite) A general name for a group of three-layer, mica-like clay minerals that are widely distributed in argillaceous sediments, esp in marine shales. They are intermediate in composition and structure between muscovite and montmorillonite, have 10-angstrom c-axis spacings with substantially no expanding-lattice characteristics, and have the general formula  $(\text{H}_3\text{O}, \text{K})_x(\text{Al}_4\text{Fe}_4\text{Mg}_4\text{Mn}_4)_y(\text{Si}_8\text{Al}_y)\text{O}_{20}(\text{OH})_4$  with  $y$  less than 2 and frequently 1 to 1.5. *Syn hydromica*.

**illuvial horizon** (il-lu-vi-al) A soil horizon to which material has been added by the process of *illuviation*.

**illuviation** (il-lu-vi-a'-tion) The accumulation, in a lower soil horizon, of soluble or suspended material that was transported from an upper horizon by the process of *eluviation*. Adj *illuvial*.

**ilmenite** (il'-men-ite) An iron-black opaque rhombohedral mineral,  $\text{FeTiO}_3$ . It is the principal ore of titanium. Ilmenite is a common accessory mineral in basic igneous rocks, esp gabbros and norites, and is also concentrated in mineral sands.

**imbibition** (im-bi-bi'-tion) The tendency of granular rock or any porous medium to absorb a fluid usually water, under the force of capillary attraction, and in the absence of any pressure.

**Imbrian** (Im'-bri-an) 1 Pertaining to lunar topographic features and lithologic map units constituting a system of rocks formed during the period of formation of the Mare Imbrium basin and of deposition of mare material of the Procellarum Group or during any time between these two events. Imbrian rocks are older than the post-mare craters and associated ejecta of the Eratosthenian and Copernican systems. 2 Said of the stratigraphic period during which the Imbrium System was developed.

**imbricate** (im'-bri-cate) Overlapping, as shingles or tiles on a roof.

**imbricate structure** 1 A sedimentary structure characterized by thin flat pebbles all tilted in the same direction, their flat sides dipping upstream. *Syn shingle structure*. 2 A tectonic structure in which a series of minor overlapping thrust faults, nearly parallel and separated by rock wedges or slices, are all inclined in the same direction, i.e. toward the source of

stress

**immature** (im-ma-ture') 1 Said of a topography or landscape feature that has not attained maturity, e.g. a valley or drainage system that is well above base level 2 Said of a clastic sediment that has evolved from its parent rock over a short time or with a low intensity, and that is characterized by unstable minerals, mobile oxides, weatherable material, and poorly sorted angular grains Cf *submature*, *mature*

**immature soil** *azonal soil*

**immiscible** (im-mis'-ci-ble) Said of two or more phases that, at mutual equilibrium, cannot dissolve completely in one another, e.g. oil and water Cf *miscible*

**impact** A forceful contact or collision between bodies, such as that involved in the production of a meteorite crater or cryptoexplosion structure Also, the degree or concentration of force in a collision

**impact crater** A depression formed by the impact of an unspecified projectile, esp. a crater formed on the earth or moon surface where the nature of the impacting body is unknown See also *meteorite crater*

**impactite** (im-pact'-ite) A vesicular, glassy to finely crystalline material produced by complete or partial fusion of target rock by the heat generated from the impact of a large meteorite, and occurring in and around the resulting crater Syn *impact slag*

**impact law** A physical law govern-

ing the settling of coarse particles, in which, for a given particle density, fluid density, and fluid viscosity, the settling velocity is directly proportional to the square root of the particle diameter Cf *Stokes' law*

**impact slag** *impactite*

**impermeable** (im-per'-me-a-ble) Said of a rock, sediment, or soil that is incapable of transmitting fluids under pressure Ant *permeable* Syn *impervious* Noun *impermeability*

**impervious** (im-per'-vi-ous) *impermeable*

**impoundment** The process of forming a lake or pond by a dam, dike, or other barrier, also, the body of water so formed

**impregnated** (im-preg'-nat-ed) Said of a mineral deposit (esp. of metals) in which the minerals are epigenetic and diffused in the host rock Cf *interstitial*

**impression** (im-pres'-sion) 1 The shape or indentation made on a soft surface of mud or sand by a harder structure, such as a fossil shell, that has come in contact with it, a shallow *mold* It occurs as a concavity on the top of a bed, a cast of it may then be found on the base of the overlying bed 2 A small circular pit formed by rain, hail, drip, or spray 3 A fossil footprint, trail, track, or burrow - Syn *imprint*

**imprint** An *impression*, esp. one made by a thin object such as a leaf, or by a falling hailstone or raindrop

**impulse** A short-period force or ac-

tion, in seismograph prospecting, the effect of an explosive or mechanical source of seismic waves

**IMW** *International Map of the World*

**inarticulate** (in-ar-tic'-u-late) *n*  
Any brachiopod belonging to the class Inarticulata, characterized by valves that are calcareous or composed of chitinophosphate and commonly held together by muscles rather than hinge teeth and dental sockets - *adj* Said of a brachiopod having such valves, or of the valves themselves Cf *articulate*

**Inceptisol** (In-cep'-ti-sol) In U.S. Dept. of Agriculture soil taxonomy, a soil order characterized by having one or more horizons in which mineral materials other than carbonates or amorphous silica have been altered or removed but not accumulated to a significant degree

**incise** Cut down into as a river cuts into a plateau

**incised meander** 1 A generic term for an old stream meander that has become deepened by rejuvenation and that is more or less closely bordered or enclosed by valley walls Two types are usually recognized *entrenched meander* and *ingrown meander*

2 Used in a more restricted sense as a syn. of *entrenched meander*  
**inclination** (in-cli-na'-tion) 1 A deviation from the vertical or horizontal, also the rate of slope, or the slope itself 2 In structural geology, it may be used as a syn. of *dip* 3 The angle of a well bore,

measured from the vertical at a stated depth 4 *magnetic inclination*

**inclined extinction** A type of extinction seen in birefringent crystal sections in which the vibration directions are inclined to a crystal axis or direction of cleavage Cf *parallel extinction*, *undulatory extinction* Syn *oblique extinction*

**inclined fold** A fold whose axial surface is inclined from the vertical, and in which one limb may be steeper than the other The term sometimes includes the restriction that the steeper of the two limbs not be overturned

**inclinomometer** (in-chi-nom'-e-ter) 1 Any of various instruments for measuring inclination in a well bore 2 An instrument that measures magnetic inclination

**included gas** (in-clud'-ed) Gas in isolated interstices in either the *zone of aeration* or the *zone of saturation*, also, bubbles of air or other gas that are surrounded by water in either zone and act as obstacles to flow until the gas disappears by dissolving in the water

**inclusion** (in-clu'-sion) 1 A fragment of older rock within an igneous rock to which it may or may not be genetically related See also *xenolith*, *autolith* 2 *fluid inclusion*

**incompetent** (in-com'-pe-tent) Said of rocks that have deformed in a ductile manner compared to adjacent more brittle rocks, e.g. the matrix around *boudins*, or of layers that have formed more nearly

*similar folds* in contrast to competent layers which have formed more nearly *parallel folds*. It is a relative term. Ant: *competent*.

**incompressibility modulus** (in'-com-pres'-si-bil'-i-ty) *bulk modulus*.

**incongruent melting** (in-con'-gru-ent) Melting accompanied by decomposition or by reaction with the liquid, so that one solid phase is converted into another; melting to give a liquid different in composition from the original solid. For example, orthoclase melts incongruently to give leucite and a liquid richer in silica than the original orthoclase.

**incongruent solution** Dissolution accompanied by decomposition or by reaction with the liquid, so that one solid phase is converted into another; dissolution to give dissolved material in different proportions from those in the original solid.

**incorporation** (in-cor'-po-ra'-tion) A process of *coalification* in which there is no modification of material. Cf: *vitrinization*; *fusinization*.

**incretion** (in-cre'-tion) A cylindrical concretion with a hollow core.

**incrustation** (in-crus-ta'-tion) *encrustation*.

**index contour** A contour line shown on a map in a distinctive manner for ease of identification, being printed more heavily than other contour lines and generally labeled with a value (such as figure of elevation) along its course.

Index contours appear at regular intervals, such as every fifth or sometimes every fourth line (depending on the contour interval). Syn: *accented contour*.

**index ellipsoid** The *indicatrix* of an anisotropic crystal.

**index fossil** A fossil that identifies and dates the strata in which it is found; esp. any fossil taxon (generally a genus, rarely a species) that combines morphologic distinctiveness with relatively common occurrence and that has a broad, even worldwide, geographic range and a narrow or restricted stratigraphic range. The best index fossils include swimming or floating organisms that evolved rapidly and were distributed widely, such as graptolites and ammonites. Cf: *characteristic fossil*; *guide fossil*.

**index horizon** A structural surface used as a reference in analyzing the geologic structure of an area. Syn: *index plane*.

**index map** 1. A map, usually of small scale, that depicts the location of a small area in relation to (or within) a larger area, e.g. a map showing a mine property in relation to the main features of the surrounding area. It is often shown in a small rectangle on a large map. 2. A map showing the location and numbers of aerial photographs or the location and names of topographic maps.

**index mineral** A mineral developed under a particular set of temperature and pressure conditions, thus characterizing a par-

ticular degree of metamorphism. It is a mineral whose first appearance (in passing from low to higher grades of metamorphism) marks the outer limit of the zone in question.

**index of refraction** In crystal optics, a number that expresses the ratio of the velocity of light in a vacuum to the velocity of light within the crystal. Its conventional symbol is  $n$ . Modifying factors include wavelength, temperature, and pressure. *Birefringent* crystals have more than one index of refraction.

**index plane index horizon**

**index zone** A stratum or body of strata recognizable by paleontologic or lithologic characters, that can be traced laterally and identifies a reference position in a stratigraphic section.

**Indiana limestone** (In-di-an'-a) *Bedford limestone*.

**indicated ore** (in-di-cat'-ed) Ore for which there are quantitative estimates of tonnage and grade, made partly from inference and partly from specific sampling. Cf. *inferred ore, possible ore, potential ore*. Syn. *probable ore*.

**indicator** (in-di-ca-tor) 1. A geologic or other feature that suggests the presence of a mineral deposit, e.g. a geochemical anomaly. 2. A plant or animal peculiar to a specific environment, which can thus be used to identify that environment. 3. A glacial *erratic* whose source and direction of transportation are known.

**indicator plant** A plant or tree that

grows exclusively or preferentially on soil rich in a given metal or other element.

**indicatrix** (in-di-ca'-trix) In optics, a geometric figure that represents the refractive indices of a crystal: it is formed by drawing, from a point representing the center of the crystal, lines in all directions, whose lengths represent the refractive indices for those vibration directions. The figure for an isotropic crystal is a sphere, for a uniaxial crystal, an ellipsoid of revolution, and for a biaxial crystal, a triaxial ellipsoid. Partial syn. *index ellipsoid*.

**indigenous** (in-dig'-e-nous) Said of an organism originating in a specific place, native. Syn. *endemic*. Ant. *exotic*.

**induced magnetization** The magnetic field spontaneously induced in a volume of rock by the uniform action of an applied field. In the absence of *remanent magnetization*, it is the magnetic moment per unit volume.

**induction** (in-duc'-tion) Reasoning from the particular to the general, or from the individual to the universal, deriving general principles from the examination of separate facts. Ant. *deduction*.

**induction log** A continuous record of the conductivity of strata traversed by a borehole as a function of depth.

**indurated** (in-du-rat-ed) Said of a rock or soil hardened or consolidated by pressure, cementation, or heat.

**induration** (in-du-ra'-tion) 1. The

hardening of a rock or rock material by heat, pressure, or the introduction of cementing material; esp. the process by which relatively consolidated rock is made harder or more compact. See also: *lithification*. 2. The hardening of a soil horizon by chemical action to form a *hardpan*.

**industrial diamond** (in-dus'-tri-al) A general term for diamonds used in drilling, in wire drawing, and as a general abrasive. See also: *ballas*; *bort*; *carbonada*.

**industrial mineral** Any rock, mineral, or other naturally occurring substance of economic value, exclusive of metallic ores, mineral fuels, and gemstones; one of the *nonmetallics*.

**inequigranular** (in-'e-qui-gran'-u-lar) *heterogranular*.

**inferred ore** Ore for which there are quantitative estimates of tonnage and grade made in only a general way, based on geologic relationships and on past mining experience, rather than on specific sampling. Cf: *indicated ore*; *possible ore*; *potential ore*.

**infiltration** (in-fil-'tra'-tion) The flow of a fluid into a solid substance through pores or small openings; specif. the movement of water into soil or porous rock. Cf: *percolation*.

**infiltration capacity** *infiltration rate*.

**infiltration rate** The rate at which a soil can absorb falling rain or melting snow; expressed in depth of water per unit time (cm/sec; in/hr). Syn: *infiltration velocity*;

*infiltration capacity*.

**infiltration velocity** *infiltration rate*.

**influent** (in-'flu-ent) adj. Flowing in.—n. 1. A stream that flows into a lake (e.g. an inlet), or a stream or branch that flows into a larger stream (e.g. a tributary). Ant: *effluent*. Cf: *influent stream*. 2. A stream that flows into a cave.

**influent stream** 1. A stream or reach of a stream that contributes water to the zone of saturation and develops bank storage; its channel lies above the water table. Syn *losing stream*. 2. *influent*.

**informal unit** (in-'for'-mal) A body of rock that is referred to casually, e.g. "sandy beds", "map unit 2", "producing zone". Cf: *formal unit*.

**infraglacial** (in-fra-gla'-cial) *subglacial*.

**infrared** (in-fra-red') Pertaining to or designating that part of the electromagnetic spectrum ranging in wavelength from 0.7  $\mu$ m to about 1 mm.

**infrastructure** (in-'fra-struc-ture) Structure produced at a deep crustal level, in a plutonic environment under high temperature and pressure, which is characterized by plastic folding and the emplacement of granite and other migmatitic and magmatic rocks. Cf: *superstructure*.

**ingrown meander** A continually growing or expanding *incised meander* formed during a single cycle of erosion by the enlargement or accentuation of an initial minor curve while the stream was

actively downcutting, a meander that "grows in place" Cf *entrenched meander*

**inherent ash** (in-her'-ent) Ash derived from mineral constituents of plant material in coal rather than from accompanying sediment. It cannot be separated mechanically from the coal. Syn *intrinsic ash*

**inherited** (in-her'-it-ed) 1 Said of a geologic structure, feature, or landscape that owes its character to conditions or events of a former period esp said of a superimposed stream, valley, or drainage system. 2 Also, said of a soil or sediment characteristic that is directly related to the nature of the parent material rather than to formative processes

**initial dip** (in-i'-tial) 1 A syn of *original dip*. 2 The dip that a bedded deposit attains due to compaction after sedimentation, but before tectonic deformation

**initial production** The volume or quantity of gas or oil initially produced by a well in a certain interval of time, usually 24 hours. Abbrev IP

**injection** (in-jec'-tion) 1 *intrusion*. 2 The forcing of sedimentary material into a crack or fissure in a pre-existing deposit or rock, e g the emplacement of wet sand as a sandstone dike; also, a sedimentary structure or rock formed in this way.

**injection complex** An assemblage or association of rocks consisting of igneous intrusions in intricate relationship to sedimentary and

metamorphic rocks, such as the ancient rocks underlying the oldest sedimentary formations in eastern U S

**injection gneiss** A composite rock whose banding is wholly or partly caused by *lit-par-lit* injection of granitic magma into layered rock. Cf *arterite*

**injection metamorphism** Metamorphism accompanied by intimate injection of sheets and streaks of liquid magma in zones near plutonic rocks

**injection well** 1 In water supply a *recharge well*. 2 A well in an oil or gas field through which water, gas, steam, or chemicals are pumped into the reservoir formation for pressure maintenance or *secondary recovery*. 3 A well for storage or disposal of injected fluid

**inland ice** 1 The ice forming the inner part of a *continental glacier* or large *ice sheet*. The term is applied esp to the ice on Greenland. 2 A continental glacier or ice sheet in its entirety

**inland sea** *epicontinental sea*

**inlet** 1 A small, narrow opening in a shoreline, through which water penetrates into the land. Cf *pass*. 2 An inflowing stream, as into a lake. 3 A short, narrow waterway, e g through a reef or barrier island leading to a bay or lagoon. 4 *tidal inlet*

**inlier** (in'-li-er) An area or group of rocks surrounded by rocks of younger age, e g an eroded anticlinal crest. Cf *outlier*

**inner core** The central part of the



earth's core, extending from a depth of about 5100 km to the center (6371 km) of the earth; its radius is about one third of the whole core. It is equivalent to the *G layer*. Cf: *outer core*. Partial syn *lower core*. Syn. *siderosphere*.

**inorganic** (in-or-gan'-ic) Pertaining or relating to a compound that contains no carbon. Cf: *organic*.

**inosilicate** (in'-o-sil'-i-cate) A class or structural type of *silicate* characterized by the linkage of the  $\text{SiO}_4$  tetrahedra into linear chains by the sharing of oxygens. In a simple chain, e.g. pyroxenes, two oxygens are shared, in a double chain or band, e.g. amphiboles, half the  $\text{SiO}_4$  tetrahedra share three oxygens and the other half share two. Syn. *chain silicate*.

**in place** Said of rock occupying, relative to surrounding masses, the position that it had when formed; not displaced or separated from the parent ledge. Cf: *in situ*.

**inselberg** (in'-sel-berg) An isolated residual knob or hill, rising abruptly from a lowland erosion surface, esp. in the desert regions of Africa and Arabia. It is characteristic of a late stage of the erosion cycle. Etymol: German, "island mountain". Cf: *bornhardt*; *monadnock*.

**insequent** (in'-se-quent) adj. Said of a stream or drainage system that is uncontrolled by the associated rock structure or surface features and wanders irregularly

across a region of low relief.—n. *insequent stream*.

**insequent stream** A stream developed on the present surface but not controlled or adjusted by the rock structure and surface features; a self-guided stream, whose resulting drainage pattern is dendritic, as a young stream wandering irregularly on a nearly level plain underlain by homogeneous or horizontally stratified rocks. Syn. *insequent*.

**inshore** 1 Situated close to the shore or indicating a shoreward position, specif. said of a zone of variable width extending from the low-water shoreline through the breaker zone. 2 In a narrow sense, said of the *shoreface*.

**inshore current** Any current in or landward of the breaker zone.

**in situ** In its natural position; said specif. of a rock, soil, or fossil when in the situation in which it was originally formed or deposited. Cf: *in place*.

**in-situ combustion** A technique used for recovering oil of low gravity and high viscosity from a reservoir when primary methods have failed. The method involves heating the oil in the formation by igniting it (burning it in place), keeping combustion alive by pumping air into the formation. As the front of burning oil advances, the heat breaks down the oil into coke and light oil, and the latter is pushed ahead to producing wells.

**in-situ theory** The theory that coal originates at the place where its

constituent plants grew and decayed. Ant: *drift theory*.

**insolation** (in-so-la'-tion) 1. The combined solar and sky radiation reaching the earth; also, the rate at which it is received, per unit of horizontal surface. Cf: *solar constant*. 2. The geologic effect of the sun's rays on the earth's surficial materials; specif. the effect of changes of temperature on the mechanical weathering of rocks.

**insoluble residue** (in-sol'-u-ble) The material remaining after the more soluble part of a rock sample has been dissolved in hydrochloric or acetic acid. It is chiefly composed of chert or quartz and various detrital minerals (e.g. anhydrite, glauconite, pyrite, and sphalerite). See also: *siliceous residue*.

**insular shelf** (in'-su-lar) An area of the ocean floor analogous to the continental shelf, but surrounding an island. Syn: *island shelf*.

**insular slope** An area of the ocean floor analogous to a continental slope, but surrounding an island. Syn: *island slope*.

**insulated stream** (in'-su-lat-ed) A stream or reach of a stream that neither contributes water to the zone of saturation nor receives water from it; it is separated from the zone of saturation by an impermeable bed.

**intake recharge**.

**intake area** An area of *recharge*.

**integrated drainage** (in'-te-grat-ed) Drainage developed during maturity in an arid region, characterized by coalescence of

drainage basins as a result of headward erosion in the lower basins or spilling over from the upper basins due to aggradation. Various higher local base levels are replaced by a single lower base level.

**intensity** (in-ten'-si-ty) *earthquake intensity*.

**intensity scale** A standard of relative measurement of *earthquake intensity*. Three such systems are the *Mercalli scale*, the *modified Mercalli scale*, and the *Rossi-Forel scale*.

**intensive variable** (in-ten'-sive) A thermodynamic variable that is independent of the total amount of matter in the system, such as temperature or pressure.

**interbed** (in'-ter-bed) A bed, typically thin, of one kind of rock material occurring between or alternating with beds of another kind.

**interbedded** Said of beds lying between or alternating with others of different character, esp. said of rock material laid down in sequence between other beds, such as a contemporaneous lava flow "interbedded" with sediments. Cf: *intercalated*. Syn: *interstratified*.

**intercalated** (in-ter'-ca-lat-ed) Said of layered material that exists or is introduced between layers of a different character; esp. relatively thin strata of one kind of material that alternate with thicker strata of some other kind, such as beds of shale intercalated in a body of sandstone.

**intercept (in'-ter-cept)** 1. The distance along a crystallographic axis at which it is cut by a crystal face. 2. One of the three linear dimensions of a sedimentary particle. 3. The part of the rod seen between the upper and lower stadia hairs of a transit or telescopic alidade.

**intercept time** The time obtained by extrapolating a seismic refraction alignment on a time-distance curve back to zero shot-to-geophone distance, the sum of the *delay times* at the shot and receiver ends of the path.

**interface (in'-ter-face)** 1 The *contact* between fluids in a reservoir. 2. The depositional boundary separating the top of the uppermost layer of sediment and the water in which the sedimentation is occurring. 3 A seismic *discontinuity*.

**interfacial angle (in'-ter-fa'-cial)** The angle between two faces of crystal.

**interference (in'-ter-fer'-ence)** 1. The masking of a desired seismic signal by others arriving at very nearly the same time. 2 The condition occurring when the area of influence of a water well comes into contact with or overlaps that of a neighboring well, as when two wells are pumping from the same aquifer or are located near each other.

**interference colors** In crystal optics, the colors displayed by a birefringent crystal in crossed, polarized light. Thickness and orientation of the sample and the

nature of the light are factors that affect the colors and their intensity.

**interference figure** The pattern or figure that a crystal displays in polarized light under the *conoscope*. It is a combination of the *isogyre* and the *isochromatic curve*, and is used to distinguish axial from biaxial crystals and to determine optical sign.

**interference ripple mark** A pattern that results from two sets of ripples, oriented differently, on the same surface. Their cell-like appearance led Edward Hitchcock to regard them as "tadpole nests". Syn: *cross ripple mark*; *complex ripple mark*.

**interfinger (in'-ter-fin'-ger)** To grade or pass from one material into another through a series of interpenetrating wedge-shaped layers.

**interfluve (in'-ter-fluve)** The relatively undissected upland between adjacent streams flowing in the same general direction.

**interfolding** The simultaneous development of discrete fold systems with different orientations.

**informational conglomerate (in'-ter-for-ma'-tion-al)** A conglomerate whose constituents have a source external to the formation in which it occurs. Cf: *intraformational conglomerate*.

**interglacial (in'-ter-gla'-cial)** Pertaining to the time between glaciations.

**intergranular (in'-ter-gran'-u-lar)** Said of the texture of an igneous rock in which the augite occurs as

an aggregation of grains, not in optical continuity, in the interstices of a network of feldspar laths that may be diverse, subradial, or subparallel. This texture is distinguished from *intersertal* texture by the absence of interstitial glass. Cf: *ophitic*.

**intergranular movement** (in-ter-gran'-u-lar) A process that goes on within a glacier when grains of ice rotate and slide over each other like grains of corn in a chute. It is a significant factor in glacier flow only near the surface of a glacier. Cf: *intragranular movement*.

**intergrowth** (in'-ter-growth) The state of interlocking of grains of two different minerals as a result of their simultaneous crystallization. Cf: *graphic granite*.

**interior basin** (in-te'-ri-or) 1. A depression surrounded by higher land, from which no stream flows outward to the ocean. Cf: *closed basin*. 2. *intracratonic basin*.

**interior valley** A large flat-floored closed depression in a karst area. Its drainage is subsurface, its size is measured in kilometers, and its floor is commonly covered by alluvium. Interior valleys may become intermittent lakes during periods of heavy rainfall, when the sinking streams that drain them cannot manage the runoff. See also: *karst valley*.

**interlaminated** (in-ter-lam'-i-nat-ed) Said of laminae occurring between or alternating with others of different character; *intercalated* in very thin layers.

**interlobate** (in-ter-lo'-bate) Situated between lobes, e.g. deposits lying between adjacent *glacial lobes*.

**intermediate** (in-ter-me'-di-ate) Said of an igneous rock that is transitional between *basic* and *silicic* (or between *mafic* and *felsic*), generally having a silica content of 54 to 65 percent; e.g. syenite and diorite. "Intermediate" is one subdivision of a widely used system for classifying igneous rocks on the basis of their silica content; the other subdivisions are *acidic*, *basic*, and *ultrabasic*.

**intermediate-focus \* earthquake** (in'-ter-med'-i-ate-fo'-cus) An earthquake whose focus occurs between depths of about 60 km and 300 km. Cf: *shallow-focus earthquake*; *deep-focus earthquake*.

**intermineral** (in-ter-min'-er-al) Pertaining to a time interval between periods of mineralization; also, to those features, e.g. dikes, that were emplaced during such an interval. See also: *intramineral*. Cf: *premineral*; *postmineral*.

**intermittent stream** (in-ter-mit'-tent) 1. A stream that flows only at certain times of the year, as when it receives water from springs or from a surface source. 2. A stream that does not flow continuously, as when water losses from evaporation or seepage exceed the available stream-flow.—Cf: *ephemeral stream*.

**intermontane** (in-ter-mon'-tane) Lying between mountains. Syn: *intermountain*.

**intermontane glacier** A glacier formed by the confluence of several alpine glaciers and occupying a depression between mountain ranges or ridges

**intermontane trough** 1 A subsiding area in an island-arc region of the ocean, lying between stable or uprising regions 2 A basin-like area between mountain ranges, sometimes occupied by an intermontane glacier

**intermountain** *intermontane*

**internal cast** (in-ter'-nal) A syn of *steinkern*. The term should not be used for an *internal mold*

**internal drainage** Surface drainage in which the water does not reach the ocean, such as drainage toward the central part of an interior basin. It is common in arid and semiarid regions

**internal mold** An impression showing the form and markings of the inner surfaces of a fossil shell or other organic structure; it is made on the surface of the rock material filling the hollow interior of the shell or organism. It can be called correctly a "cast of the interior" only if the shell or structure itself is regarded as a mold. Cf. *external mold*, *internal cast*. See also *steinkern*.

**internal rotation** In structural petrology, a change in the orientation of structural features during deformation, referred to coordinate axes internal to the deformed body. Cf. *external rotation*.

**internal wave** A submerged wave occurring on a density surface, e.g. the thermocline, in density-

stratified water. Because of the small density gradients involved, the heights, periods, and wavelengths are usually large.

**International Active Sun Years** (In-ter-na'-tion-al) An international cooperative program for the scientific investigation of solar-terrestrial phenomena during periods of maximum sunspot activity.

**International Geophysical Year** An international cooperative program conducted from July 1, 1957, to December 31, 1958, for the observation of geophysical phenomena. The interval was near a maximum in sunspot activity.

**International Hydrological Decade** A ten year program, 1965-74, patterned after the International Geophysical Year, aimed at training hydrologists and technicians and at establishing networks for measuring hydrologic data. The idea originated in the United States, but the program was sponsored by UNESCO, and a large proportion of the membership of the United Nations participated.

**International Map of the World** A map series at a scale of 1/1,000,000 (one inch to 15.78 miles), having a uniform set of symbols and conventional signs, using the metric system for measuring distances and elevations, and printed in modified polyconic projection on 840 sheets, each covering an area of 4° lat and 6° long except above the 60th parallel where the

longitude covered is 12° on each sheet. It was first suggested at the 5th International Geographical Congress in 1891 and was accepted in principle in 1909. It consists of an incomplete series of map sheets (many needing revision) generally published by national mapping agencies of concerned countries under the auspices of the United Nations.

**International Years of the Quiet Sun** An international cooperative program for the scientific investigation of solar terrestrial phenomena during periods of minimum sunspot activity.

**interpretive log** (in-ter'-pre-tive) A *sample log* based on rotary well cuttings, in which the geologist attempts to show only the rock encountered by the bit at each sampled depth, ignoring the admixed material from higher levels. Cf. *percentage log*.

**interpretive map** As used in environmental geology, a map prepared for the general public that classifies the suitability of land for a particular use on the basis of geologic characteristics. Examples: general construction, sand and gravel development, land burial of waste, ground-water development.

**interrupted profile** (in-ter-rupt'-ed) The break or interruption in a longitudinal stream profile where, after rejuvenation, the head of the second-cycle valley touches the first-cycle valley. See also *knick point*.

**interrupted stream** A stream that

contains perennial reaches with intervening intermittent or ephemeral reaches, or one that contains intermittent reaches with intervening ephemeral reaches.

**interrupted water table** A water table that slopes steeply over a *ground-water barrier* with pronounced difference in elevation above and below it.

**intersection** (in-ter-sec'-tion) 1 A method in surveying by which the horizontal position of an unoccupied point is determined by drawing lines to that point from two or more points of known position. Cf. *resection*. 2 Determination of positions by triangulation.

**intersertal** (in-ter-ser'-tal) Said of the texture of a porphyritic igneous rock in which the groundmass, composed of a glassy or partly crystalline material other than augite, occupies the interstices between unoriented feldspar laths, the groundmass forming a relatively small proportion of the rock. Cf. *hyalopilitic*, *hyalophitic*, *hyalocrystalline*.

**interstade** (in'-ter-stade) A warmer substage of a glacial stage, marked by a temporary retreat of the ice.

**interstice** (in-ter'-stice) An opening or space in a rock or soil. Syn. *pore*, *void*.

**interstitial** (in-ter-sti'-tial) Said of a mineral deposit in which the minerals fill the pores of the host rock. Cf. *impregnated*.

**interstratified** (in-ter-strat'-i-fied) *interbedded*.

**intertongued lithofacies** (in-ter-tongued') A body of sedimentary rock, e.g. sandstone, that has an *intertonguing* boundary with adjacent rock of different character, e.g. shale. Syn. *lithosome* as originally defined.

**intertonguing** (in-ter-tongu'-ing) The disappearance of sedimentary bodies in laterally adjacent masses owing to splitting into many thin *tongues*, each of which reaches an independent pinch-out termination, the intergradation of markedly different rocks through a vertical succession of thin interlocking or overlapping wedge-shaped layers.

**interval velocity** (in'-ter-val) The distance across a given stratigraphic thickness divided by the time for a seismic wave to traverse it, the *average velocity* measured over a depth interval, e.g. in a sonic log or borehole survey. It usually refers to compressional velocity and implies measurement perpendicular to bedding.

**intraclast** (in'-tra-clast) A component of a limestone consisting of a torn-up, rounded, and reworked fragment of a weakly consolidated penecontemporaneous sediment that has been redeposited to form a new sediment.

**intracratonic** (in'-tra-cra-ton'-ic) Situated within a stable continental region.

**intracratonic basin** A basin on top of a *craton*. Syn. *interior basin*.

**intracyclothem** (in'-tra-cy'-clo-them) A cyclic sequence of strata resulting from the splitting of a

cyclothem.

**intradelta** (in'-tra-del'-ta) The landward part of a delta, largely subaerial but extending for a short distance below the water level, marked by a great diversity of environments and commonly covered by marshes and swamps, it contains the distributary channels, flanked by levees. Cf. *prodelta*. Syn. *delta top*.

**intrafacies** (in'-tra-fa-cies) A minor or subordinate facies occurring within a differing major facies.

**intraformational** (in'-tra-for-ma'-non-al) 1 Formed within a geologic formation, more or less contemporaneously with the enclosing sediments. The term is especially used in regard to syndepositional folding or slumping, e.g. "intraformational deformation." 2 Existing within a formation, with no necessary connotation of time of origin.

**intraformational breccia** A rock formed by brecciation of partly consolidated material, followed by practically contemporaneous sedimentation. It is similar in nature and origin to an *intraformational conglomerate* but contains fragments showing greater angularity.

**intraformational conglomerate** A conglomerate whose constituents are derived from the formation in which it occurs. Cf. *interformational conglomerate*.

**intrageosyncline** (in'-tra-ge-o-syn'-cline) *parageosyncline*.

**intragranular movement** (in'-tra-

**gran'-u-lar)** A gliding movement by which favorably oriented ice crystals are deformed by slip along layers, without breaking the continuity of the crystal lattice. It is an important mechanism in glacier flow. Cf: *intergranular movement*.

**intramineral** (in-tra-min'-er-al) Pertaining to the time interval of a period of mineralization; also, pertaining to those features, e.g. a breccia mineralized during its formation, that were emplaced during such an interval. See also: *intermineral*. Cf: *premineral*; *post-mineral*.

**intrastratal solution** (in-tra-strat'-al) Removal by chemical solution of certain mineral species from within a sedimentary bed following deposition.

**intratelluric** (in'-tra-tel-lu'-ric) 1. Said of a phenocryst that formed at depth, prior to extrusion of a magma as lava. 2. Said of that period of crystallization occurring deep within the earth just prior to the extrusion of a magma as lava. 3. Located, formed, or originating deep within the earth.

**intrazonal soil** (in-tra-zon'-al) A soil with more or less well-developed characteristics that reflect the dominating influence of some local factor of relief, parent material, or age over the normal effects of the climate and vegetation. Cf: *zonal soil*; *azonal soil*.

**intrenched meander** *entrenched meander*.

**intrenched stream** *entrenched stream*.

**intrinsic ash** (in-trin'-sic) *inherent ash*.

**intrusion** (in-tru'-sion) 1. The process of emplacement of magma in pre-existing rock; magmatic activity. Also, the igneous rock mass so formed. Syn: *injection*. 2. An injection of sedimentary material under abnormal pressure, e.g. the emplacement of a diapiric salt plug; also, a structure or rock so formed. 3. *salt-water encroachment*.

**intrusion displacement** Faulting coincident with the intrusion of an igneous rock.

**intrusive** (in-tru'-sive) adj. Of or pertaining to *intrusion*, both the process and the rock so formed —n. An intrusive rock —Cf: *extrusive*.

**intrusive breccia** A heterogeneous mixture of angular to rounded fragments in a matrix of clastic material, which has been mobilized and intruded into its present position along pre-existing structures. It is commonly hydrothermally altered.

**intrusive rock** A rock formed by *intrusion*.

**invariant equilibrium** (in-var'-i-ant) A phase assemblage having zero degrees of freedom, i.e., neither temperature, pressure, nor composition may be varied without loss of one or more phases.

**invasion** (in-va'-sion) 1. *Igneous intrusion*. 2. *Transgression* of the sea across a land surface.

**inverse zoning** In plagioclase, the change by which crystals become more calcic in their outer parts.



*Cf:* normal zoning. *Syn:* reversed zoning.

**inversion** (in-ver'-sion) 1. A change of phase, generally from one solid to another of different structure but the same composition, e.g. quartz to tridymite. *Syn:* transformation. 2. *inverted relief.* 3. A reversal of a normal meteorological gradient, as an increase rather than a decrease of temperature with height. 4. Construction of a general geophysical model from an array of logical data points.

**inversion point** 1. The temperature at which one polymorphic form of a substance, in equilibrium with its vapor, reversibly changes into another under univariant conditions. 2. The temperature at which one polymorphic form of a substance inverts reversibly into another under univariant conditions and a specific pressure. 3. Loosely used for the lowest temperature at which an unstable phase inverts at an appreciable rate into a stable phase, or at which a given phase dissociates at an appreciable rate, under given conditions. 4. A single point at which different phases are capable of existing together at equilibrium.

**invertebrate** (in-ver'-to-brate) *n.* An animal belonging to the Invertebrata, i.e. without a backbone, such as the mollusks, arthropods, and coelenterates.—*adj.* Of or pertaining to an animal that lacks a backbone.

**inverted plunge** The plunge of

folds, or sets of folds, whose inclination has been carried past the vertical, so that the plunge is now less than 90° in a direction opposite from the original attitude. It is a rather common feature in excessively folded or refolded terranes. **inverted relief** A topographic surface that is out of phase with the geologic structure, as where valleys are underlain by anticlines and mountains by synclines. *Syn:* inversion.

**involute** (in'-vo-lute) Referring to coiled shells in which there is considerable overlap of older whorls by younger whorls.

**involution** (in-vo-lu'-tion) 1. A highly irregular, aimlessly contorted sedimentary structure, developed by the formation, growth, and melting of ground ice in the active layer overlying permafrost. *Cf:* congeliturbation. 2. The refolding of nappes, resulting in highly complex patterns of association.

**ion exchange** Reversible exchange of ions contained in a crystal for different ions in solution without destroying crystal structure or disturbing electrical neutrality. It is accomplished by diffusion and occurs most easily in crystals having one- or two-dimensional channelways where ions are relatively weakly bonded; it also takes place at higher temperatures in network silicates, involving the most weakly bonded cations such as those of potassium and sodium. Ion exchange is also common in resins consisting of three-di-

mensional hydrocarbon networks to which many ionizable groups are attached. See also: *base exchange*.

**ionic substitution** The replacement of one or more kinds of ion in a crystal structure by other kinds of generally similar size and charge. Syn: *diadochy*.

**ionization chamber** (i'-on-i-za'-tion) A device roughly similar to a Geiger counter that reveals the presence of ionizing radiation.

**ionization potential** The voltage required to drive an electron from an atom or molecule, leaving a positive ion.

**ionosphere** (i-on'-o-sphere) The highest layer of the earth's atmosphere in which ionization takes place. It lies above the stratosphere; its lower limit is at an altitude of about 56 km in the daytime and 96 km during the night. The ionosphere reflects radio signals.

**Iowan** (I'-o-wan) Originally defined as a separate stage between the Illinoian and Wisconsinan, and later as the earliest substage of the Wisconsinan. The area of Iowan drift in northeastern Iowa is now recognized as an erosional surface cut into the Kansan till plain.

**IP** 1. *initial production*. 2. *induced polarization*.

**IR** 1. *insoluble residue*. 2. *infrared*.

**iridescence** (ir-i-des'-cence) The exhibition of prismatic colors (producing rainbow effects) in the interior or on the surface of a min-

eral, caused by interference of light from thin films or layers of different refractive index.

**iron** A heavy magnetic malleable and ductile chemically active mineral, the native metallic element Fe. Native iron is rare in terrestrial rocks but common in meteorites. In combination with other elements, iron occurs in a wide range of ores and in most igneous rocks. It is the most widely used of the metals.

**iron bacteria** Anaerobic bacteria that precipitate iron oxide from solution, either by oxidizing ferrous salts or by releasing oxidized metals from organic compounds. Accumulations of iron developed in this way are *bacteriogenic* ore deposits. Cf: *sulfur bacteria*.

**iron formation** A chemical sedimentary rock, typically thin-bedded and/or finely laminated, containing at least 15% iron of sedimentary origin and commonly containing layers of chert. The iron may be present as oxide, silicate, carbonate, or sulfide. Most iron formation is of Precambrian age. Cf: *ironstone*; *jaspilite*. Many terms are essentially synonymous, among them *taconite*, *itabirite*, *banded hematite quartzite*, *banded iron formation*, and *calico rock*.

**iron hat gossan**.

**iron meteorite** A meteorite consisting essentially of iron with up to 30% of nickel in solid solution.

**iron ore** Ferruginous rock containing one or more minerals from which metallic iron may be profitably extracted. The chief ores of

iron consist mainly of the oxides: hematite ( $\text{Fe}_2\text{O}_3$ ); goethite ( $\alpha\text{-FeO(OH)}$ ); magnetite ( $\text{Fe}_3\text{O}_4$ ); and the carbonate, siderite ( $\text{FeCO}_3$ ).

**iron pan** A type of *hardpan* in which a considerable amount of iron oxide is present.

**iron range** A term used in the Great Lakes region of the U.S. and Canada for a productive belt of iron formations. The term implies a linear region rather than a topographic elevation

**ironstone** 1. Any rock containing a substantial proportion of an iron compound, specif. an iron-rich sedimentary rock. The term is customarily applied to hard, coarsely banded or nonbanded, noncherty sedimentary rock of post-Precambrian age, in contrast with *iron formation*. Most ironstones containing iron oxide are oolitic 2. *clay ironstone*.

**irreversible process** (ir-re-vers'-i-ble) Any process that proceeds in one direction spontaneously, without external interference.

**irrotational strain** (ir-ro-ta'-tion-al) Strain at a point, in which the orientation of the principal axes of strain remains unchanged Cf: *rotational strain*.

**irrotational wave** *P wave*.

**is anomaly** (is-a-nom'-a-ly) *is anomaly*.

**isoglass** (i'-sin-glass) Muscovite in thin transparent sheets.

**island** 1. A tract of land smaller than a continent, surrounded by the water of an ocean, sea, lake, or stream. 2. An elevated piece of

land surrounded by a swamp, marsh, or alluvial land, or isolated during floods. 3. Any isolated and distinctive tract of land surrounded by terrain with other characteristics; e.g. a woodland surrounded by prairie or flat open country

**island arc** A curved chain of islands, e.g. the Aleutians, rising from the deep-sea floor and near to the continents. Its curve is generally convex toward the open ocean.

**island shelf** *insular shelf*.

**island slope** *insular slope*.

**iso-** A prefix meaning "equal", e.g. in *isopach*, equal thickness, or *isotherm*, equal temperature.

**is anomaly** (i'-so-a-nom'-a-ly) A line connecting points of equal geophysical *anomalies* Syn. *is anomaly*.

**isobaric surface** (i-so-bar'-ic) A surface on which every point has the same barometric pressure.

**isobath** (i' so-bath) 1. A line on a map or chart that connects points of equal water depth. 2. An imaginary line on a land surface along which all points are the same vertical distance above the upper or lower surface of an aquifer or above the water table.

**isocal** (i'-a'-cal) On a map or diagram, a line connecting points of equal calorific value in coal. Cf: *isocarb*.

**isocarb** (i'-so-carb) On a map or diagram, a line connecting points of equal fixed-carbon content in coal. Cf: *isocal*.

**isochemical series** (i-so-chem'-i-

cal) Rocks displaying the same bulk chemical composition throughout a sequence of mineralogic or textural changes, as in a sequence of metamorphic rocks of varying grade

**isochore** (i'-so-*chore*) 1 A line drawn on a map through points of equal drilled thickness of a specified subsurface unit Thickness figures are uncorrected for dip Cf *isopach* 2 In a phase diagram, a line connecting points of constant volume

**isochore map** 1 A map showing drilled thickness of a given stratigraphic unit by means of *isochores* Syn *convergence map* 2 A map showing by contours the thickness of the pay section of an oil pool between the oil water contact and the roof rock It is used for making calculations of reservoir volume - Cf *isopach map*

**isochromatic curve** (i-so-*chromat'-ic*) In optics of biaxial and uniaxial crystals, a band of color indicating the emergence of those components of light having equal path difference It is a part of the *interference figure*

**isochron** (i'-so-*chron*) 1 In seismology, a line passing through points at which the difference between arrival times of seismic waves from two reflecting surfaces is equal 2 In geochronology, a straight line on a graph that shows the relation between the daughter-isotope/nonradiogenic-isotope ratio and the parent/daughter-isotope ratio The slope

of an isochron increases with the age of the systems investigated

**isochrone** (i'-so-*chrone*) A line, on a map or chart, connecting all points at which an event or phenomenon occurs simultaneously or which represent the same time value or time difference, e.g. a line along which duration of wave travel is constant

**isochroneity** (i-so-*chrone'-i-ty*) The state or quality of being *isochronous*, equivalence in duration

**isochronous** (i-soch'-*ro-nous*) 1 Equal in duration or uniform in time, e.g. an "isochronous interval" between two synchronous surfaces 2 A term frequently applied in the sense of *synchronous* such as an "isochronous surface" having everywhere the same age or time value within a body of strata

**isochronous surface** A time plane within a body of sediment or sedimentary rocks

**isoclinal** (i-so-*cli'-nal*) Adj of *isocline*

**isoclinal fold** *isocline*

**isocline** (i'-so-*cline*) A fold whose limbs are parallel Adj *isoclinal* Syn *isoclinal fold*

**isoclinic line** (i-so-*clin'-ic*) A line connecting points of equal magnetic inclination

**isocon** (i'-so-*con*) A line connecting points of equal geochemical concentration, e.g. salinity

**isodimorphism** (i'-so-di-*mor'-phism*) The characteristic of two crystalline substances to be both dimorphous and isomorphous.

e.g. calcite and aragonite. Adj: *isodimorphous*.

**isodynamic line** (i'-so-dy-nam'-ic) *isogam*.

**isofacial** (i-so-fa'-cial) 1. Pertaining to rocks belonging to the same stratigraphic facies, e.g. an "isofacial line" on a map, along which the thickness of stratum of the same lithologic composition is constant. 2. Pertaining to rocks belonging to the same metamorphic facies and having reached equilibrium under the same set of physical conditions. Cf: *isograd*.

**isofacies map** (i-so-fa'-cies) A map showing the distribution of one or more facies within a designated stratigraphic unit. See also: *facies map*.

**isogal** (i'-so-gal) A contour line of equal gravity values. Cf: *gal*.

**isogam** (i'-so-gam) A line connecting points of equal magnetic-field intensity. It is used for maps of total, horizontal, or vertical magnetic intensity. Syn: *isodynamic line*.

**isogeotherm** (i-so-ge'-o-therm) A line or surface within the earth connecting points of equal temperature. Cf: *isotherm*.

**isogonic line** (i-so-gon'-ic) A line connecting points of equal magnetic declination. Cf: *agonic line*.

**isograd** (i'-so-grad) A line on a map joining points at which metamorphism proceeded at similar values of pressure and temperature, as indicated by rocks belonging to the same metamorphic facies. Such a line represents the

intersection of an inclined surface with the earth's surface corresponding to the boundary between two contiguous facies or zones of metamorphic grade, as defined by the appearance of specific index minerals, e.g. garnet isograd, staurolite isograd.

**isogyre** (i'-so-gyre [i'-so-jire]) In crystal optics, a black or shadowy part of the interference figure that is produced by extinction and indicates the emergence of those components of light having equal vibration direction. It may look like one arm of a black cross.

**isohyetal line** (i-so-hy'-e-tal) A line on a map connecting points that receive the same amount of precipitation.

**isolith** (i'-so-lith) 1. An imaginary line connecting points of similar lithology and separating rocks of differing nature, such as of color, texture, or composition. 2. An imaginary line of equal aggregate thickness of a given lithologic type within a formation, measured perpendicular to the bedding at selected points.

**isolith map** A map that depicts isoliths; esp. a *facies map* showing the net thickness of a single rock type or selected rock component in a given stratigraphic unit.

**isomagnetic** (i'-so-mag-net'-ic) Designating or pertaining to a line connecting points of equal magnetic force.

**isometric projection** (i-so-met'-ric) A projection in which the plane of projection is equally inclined to the three spatial axes of a three-

dimensional object, so that equal distances along the axes are drawn equal. It gives a bird's-eye view, combining the advantages of a ground plan and elevation; e.g. as in a block diagram showing three faces.

**isometric system** One of the six crystal systems, characterized by four threefold axes of symmetry as body diagonals in a cubic unit cell of the lattice. It comprises five crystal classes or point groups. Syn: *cubic system*.

**isomorphism** (i-so-mor'-phism) 1. The characteristic of two or more crystalline substances to have similar chemical compositions, axial ratios, and crystal forms, and to crystallize in the same class. Such substances form an *isomorphous series*. 2. The similarity that develops in organisms of different ancestry as a result of evolutionary *convergence*.

**isomorphous** (i-so-mor'-phous) Adj. of *isomorphism*.

**isomorphous series** Two or more crystalline substances that display *isomorphism*; their physical properties vary along a smooth curve. An example is olivine, usually found in nature as a solid solution of  $Mg_2SiO_4$  and  $Fe_2SiO_4$ , i.e. an isomorphous series between *forsterite* and *fayalite*. The exact lattice dimensions and other physical properties vary with change of the Mg/Fe ratio.

**isopach** (i'-so-pach) A line drawn on a map through points of equal true thickness of a designated stratigraphic unit or group of

stratigraphic units. Cf: *isochore*.  
**isopach map** A map that shows the thickness of a bed, formation, sill, or other tabular body throughout a geographic area by means of isopachs at regular intervals. Cf: *isochore map*. Syn: *thickness map*. Nonrecommended syn: *isopachous map*.

**isopachous** (i-so-pach'-ous) Of, relating to, or having an isopach; e.g. an "isopachous map". Not recommended usage.

**isopiestic line** (i'-so-pi-es'-tic) *equipotential line*.

**isopleth** (i'-so-plēth) 1. A general term for a line on a map or chart that connects points of equal value, e.g. of elevation, or of any quantity that can be numerically measured and plotted on a map; a *contour*. 2. In geochemistry, a line or surface on which some mathematical function has a constant value.

**isopycnic** (i-so-pyc'-nic) adj. Of constant or equal density, measured in space or in time.—n. A line on a chart that connects points of equal density.

**isorad** (i'-so-rad) A line connecting points of equal radioactivity.

**isoseismal line** (i-so-seis'-mal) A line connecting points on the earth's surface at which earthquake intensity is the same. It is usually a closed curve around the *epicenter*.

**isostasy** (i-sos'-ta-sy) The condition of equilibrium, comparable to floating, of the units of the lithosphere above the asthenosphere. Two differing concepts of

the mechanism of isostasy are called the *Airy hypothesis* and the *Pratt hypothesis*. See also: *isostatic compensation*; *depth of compensation*.

**isostatic** (i-so-stat'-ic) Adj. of *isostasy*.

**isostatic adjustment** *isostatic compensation*.

**isostatic anomaly** A gravity anomaly calculated on a hypothesis that the gravitational effect of masses extending above sea level is approximately compensated by a deficiency of density of the material beneath those masses; the effect of deficiency of density in ocean waters is compensated by an excess of density in the material under the oceans.

**isostatic compensation** The adjustment of the lithosphere of the earth to maintain equilibrium among units of varying mass and density, excess mass above is balanced by a deficit of density below, and vice versa. See also: *depth of compensation*; *isostasy*. Syn: *isostatic adjustment*.

**isostatic correction** The adjustment made to values of gravity or to deflections of the vertical, observed at a point, to take account of the assumed mass deficiency under topographic features for which a topographic correction is also made.

**isostratification map** (i'-so-strat'-i-fi-ca'-tion) A map that shows the number or thickness of beds in a stratigraphic unit by means of contour lines representing equal values of the *stratification index*.

**isostructural** (i-so-struc'-tur-al) Said of two or more chemical compounds with similar crystal structures, but with little tendency to show isomorphism.

**isotherm** (i'-so-therm) A line connecting points of equal temperature. Isotherm maps are often used to portray surface temperature patterns of water bodies. Cf: *isogeotherm*.

**isothermal** (i-so-ther'-mal) Pertaining to the process of changing the thermodynamic state of a substance, e.g. its pressure and volume, while maintaining the temperature constant.

**isotope** (i'-so-tope) One of two or more species of the same chemical element, i.e. having the same number of protons in the nucleus, but differing from one another by having a different number of neutrons. The isotopes of an element have slightly different physical and chemical properties, owing to their mass differences, by which they can be separated. See also: *radioisotope*.

**isotope dilution** An analytical method in which a known quantity of an element with an isotopic composition different from that of the natural element (a *spike*) is mixed with the sample being analyzed. Measurement of the isotopic composition of the mixture allows calculation of the amount of the natural element in the sample.

**isotope geology** The application of the study of radioactive and stable isotopes, especially their

abundances, to geology. It includes the calculation of geologic time, and the determination of the origin, mechanisms, and conditions of geologic processes by isotopic means.

**isotopic (i-so-top'-ic)** 1. Pertaining to an *isotope*. 2. Said of rocks formed in the same environment, such as in the same sedimentary basin or geologic province.

**isotopic fractionation** The relative enrichment of one isotope of an element over another, owing to slight variations in their physical and chemical properties. It is proportional to differences in their masses.

**isotropic (i-so-trop'-ic)** Said of a medium whose properties are the same in all directions; in crystal optics, said of a crystal whose physical properties do not vary with crystallographic direction, e.g. one in which light travels with the same speed in any direction. Cubic crystals and amorphous substances are usually isotropic.

Ant: *anisotropic*.

**isotropy (i-sot'-ro-py)** The condition of having properties that are uniform in all directions. Adj: *isotropic*.

**Isthmus (isth'-mus)** A narrow strip of land, bordered on both sides by water, that connects two larger bodies of land. See also: *submarine isthmus*.

**Itabirite (it-a-bi'-rite)** A laminated, metamorphosed oxide-facies iron

formation, in which the original chert or jasper bands have been recrystallized into megascopically distinguishable grains of quartz and the iron is present as thin layers of hematite, magnetite, or martite. Originally applied in Itabira, Brazil, to a high-grade massive specular-hematite (re (66% iron) associated with a schist of quartz and hematite, the term is now widely used outside Brazil. See also: *jaspilite*; *taconite*. Syn: *banded-quartz hematite*; *hematite schist*.

**itacolumite (it-a-col'-um-ite)** A micaceous sandstone or schistose quartzite that contains interstitial, loosely interlocking grains of mica, chlorite, and talc, and is flexible when split into thin slabs. Type locality: Itacolumi Mountain in the state of Minas Gerais, Brazil. Syn: *flexible sandstone*.

**iterative evolution (it'-er-a-tive)** Repeated development of new forms from the same ancestral stock; repeated, independent evolution.

**IUGS classification** An internationally adopted classification of plutonic rocks, presented in 1973 by the International Union of Geological Sciences. It is based on modal proportions of minerals in five groups: quartz and other polymorphs of SiO<sub>2</sub>; alkali feldspars; calcic plagioclase + scapolite; feldspathoids; and all other phases (mafic minerals).



## J

**Jacob's staff** (Ja'-cob's) A single straight rod, pointed and shod with iron at its lower end for insertion in the ground, and fitted with a ball-and-socket joint at its upper end for adjustment to a level position, used instead of a tripod for mounting and supporting a surveyor's compass or other instrument

**jade** 1 A hard, extremely tough gemstone consisting of either the pyroxene mineral *jadeite* or the amphibole mineral *nephrite*, ranging in color from dark green to greenish white. It takes a high polish, and has long been used for jewelry, carved articles, and various ornamental objects. Syn *jadestone* 2 A term often applied to various hard green minerals, e.g. "California jade" (californite, a green compact variety of *vesuvianite*)

**jadeite** A high-pressure mineral of the clinopyroxene group, essentially  $\text{Na}(\text{Al}, \text{Fe})\text{Si}_2\text{O}_6$ . It occurs in various colors (esp. green) and is found chiefly in Burma; it furnishes the most valuable and desirable variety of jade and is used for ornamental purposes

**jaspagate** (jas'-pag'-ate) A jasper agate, in which jasper usually predominates

**jasper** (jas'-per) 1 A variety of *chert* associated with iron ores and containing iron-oxide impurities that give it various colors, esp. red 2 Any red chert or chal-

cedony irrespective of associated iron ore. Syn *jasperoid*.

**jasperoid** (jas'-per-oid) n 1 A dense, chertlike siliceous rock, in which chalcedony or cryptocrystalline quartz has replaced the carbonate minerals of limestone or dolomite, a silicified limestone. It typically develops as the gangue of metasomatic sulfide deposits of the lead-zinc type, such as those of Missouri, Oklahoma, and Kansas 2 *jasper* - adj Resembling jasper

**jaspilite** (jas'-pi-lite) A rock consisting essentially of red jasper and iron oxides in alternating bands. See also *itabirite*, *taconite*, *iron formation*

**jet** A dense black lignite, taking a good polish. Sometimes used for jewelry

**jetty** 1 An engineering structure, such as a breakwater, extending out from the shore, designed to direct the current or tide, protect a harbor, induce scouring, or prevent shoaling of a navigable passage by sand. Jetties are often built in pairs on either side of a harbor entrance, or at the mouth of a river 2 A British term for a wharf or pier

**jig** Device for concentrating minerals. Crushed ore is fed into a box containing water whose level is rapidly raised and lowered by action of a piston causing heavier minerals to sink to the bottom from which they are drawn off

**Johannsen's classification** (Johann'-sen's) A quantitative mineralogical classification of igneous

rocks developed by the petrographer Albert Johannsen (1939).

**JOIDES** Joint Oceanographic Institutions for Deep Earth Sampling. A program to obtain cores of sediments in the deep oceans.

**join** The line or plane drawn between any two or three composition points in a phase diagram. There is no special phase significance to a join; it need not be a limiting binary or ternary subsystem.

**joint** A surface of fracture or parting in a rock, without displacement; the surface is often plane and may occur with parallel joints to form a *joint set*.

**joint set** A group of more or less parallel joints. See also: *joint system*.

**joint system** Two or more *joint sets* that intersect. They may be of the same age or of different ages.

**Jolly balance** In mineral analysis, a delicate spring balance used to measure specific gravity.

**J-type lead** *Anomalous lead* that gives model ages younger than the age of the enclosing rock, in some cases even negative model ages. Cf: *B-type lead*. Syn: *Joplin-type lead*.

**jug** A colloquial syn. of *geophane*.

**Jura** *Jurassic*.

**Jurassic** (Ju-ras'-sic) The second period of the Mesozoic era (after the Triassic and before the Cretaceous), thought to have covered the span of time between 190 and 135 million years ago; also, the corresponding system of rocks. It is named after the Jura Mountains between France and Switzerland, in which rocks of this age were first studied. Syn: *Jura*.

**juvenile** (ju'-ve-nile) 1. In geomorphology, a syn. of *youthful*. 2. Said of water, gas, or ore-forming fluid that is derived from a magma, as opposed to fluids of surface, connate, or meteoric origin. 3. Said of pyroclastics derived directly from magma reaching the surface.

# K

**kainite** (kai'-nite) A usually whitish monoclinic mineral,  $\text{MgSO}_4 \cdot \text{KCl} \cdot 3\text{H}_2\text{O}$ . It is a natural salt occurring in irregular granular masses, and is used as a source of potassium and magnesium compounds.

**Kainozoic** (Kai-no-zo'-ic) *Cenozoic*.

**kame** A mound, knob, or short irregular ridge, composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier, by a superglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice. Etymol: a Scottish variant of "comb", a steep-sided ridge. Cf: *esker*.

**kame-and-kettle topography** *knob-and-kettle topography*.

**kame complex** An assemblage of kames, constituting a hilly landscape.

**kame field** A group of closely spaced kames, interspersed in places with kettles and eskers, and having a characteristic hummocky topography.

**kame moraine** 1. An *end moraine* that contains numerous kames. 2. A group of kames along the front of a stagnant glacier, commonly comprising the slumped remnants of a formerly continuous outwash plain built up over the foot of rapidly wasting or stagnant ice.—See also: *moraine kame*.

**kame terrace** A terracelike ridge consisting of stratified sand and gravel formed as a *glaciofluvial* or *glaciolacustrine* deposit between a melting glacier or a stagnant ice lobe and a higher valley wall or lateral moraine, and left standing after the disappearance of the ice; a filling of a *fosse*. It is commonly pitted with kettles and has an irregular ice-contact slope.

**Kansan** (Kan'-san) Pertaining to the classical second glacial stage of the Pleistocene Epoch in North America, after the Aftonian interglacial stage and before the Yarmouthian. See also: *Mindel*.

**kaolin** (ka-o'-lin) 1. A group of clay minerals with a two-layer crystal structure in which each silicon-oxygen sheet is alternately linked with one aluminum-hydroxyl sheet, and having the approximate composition  $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$ . The kaolin minerals are generally derived from alteration of alkali feldspars and micas. The group includes *kaolinite*. 2. A soft white nonplastic clay, composed principally of kaolinite, much used in making ceramics, refractories, and paper.

**kaolinite** (ka-o'-lin-ite) 1. A common clay mineral of the kaolin group:  $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$ . It is the characteristic mineral of most kaolins, and is polymorphous with dickite and nacrite. Kaolinite is a high-alumina clay mineral that does not appreciably expand under varying water content and does not exchange iron or magnesium. The mineral was formerly

known as kaolin. 2. A name sometimes applied to the kaolin group of clay minerals, and formerly applied to individual minerals of that group (e.g. dickite and nacrite).

**K-Ar age method** *potassium-argon age method.*

**karat** (kar'-at) The proportion of pure gold in an alloy. Pure or fine gold is 24 karat; 10-karat gold is 10/24 pure, or 10 parts of pure gold by weight mixed with 14 parts of other metals. Not to be confused with *carat*. Abbrev k.

**karren** (kar'-ren) The furrows that occur from solution by rain wash on limestone in karst areas. They range in width from a few millimeters to more than a meter, and are commonly separated by sharp ridges Etymol German, "wheel tracks".

**karst** A type of topography that is formed over limestone, dolomite, or gypsum by dissolution, and that is characterized by sinkholes, caves, and underground drainage.

**karst plain** A plain, usually of limestone, on which karst features are developed.

**karst valley** A closed depression formed by the coalescence of several *sinkholes*. Its drainage is subsurface, its size is measured in hundreds of meters to a few kilometers, and it usually has an irregular floor and a scalloped margin inherited from the sinkholes.

Syn: *solution valley*; *valley sink*; *uvala*. See also: *interior valley*.

**katamorphism** (kat-a-mor'-phism)

Destructive metamorphism at or

near the earth's surface, in which complex minerals are broken down and altered through oxidation, hydration, solution, and allied processes to produce simpler and less dense minerals. Cf: *anamorphism*.

**katatectic layer** (kat-a-tec'-tic) A layer of solution residue, generally consisting of gypsum and/or anhydrite, in salt-dome caprock.

**katazone** (kat'-a-zone) The lowermost *depth zone* of metamorphism, characterized by high temperatures (500°-700°C), strong hydrostatic pressure, and little or no shearing stress. Rocks produced include high-grade schists and gneisses, granulites, eclogites, and amphibolites Cf: *mesozone*; *epizone*.

**Katmaiian-type eruption** (Kat-mai'-an-type) The violently explosive ejection of huge amounts of pumice and ash, followed by an *ash flow* and extensive fumarole activity. Type area: vicinity of Mount Katmai, Alaska, including Valley of Ten Thousand Smokes. Cf: *Peléan-type eruption*; *Vulcanian-type eruption*.

**K-bentonite** *potassium bentonite.*

**Keewatin** (Kee-wa'-tin) A division of the Archeozoic rocks of the Canadian Shield.

**kelly** A steel pipe of square or hexagonal cross section, 40 ft (12 m) long, forming the top section of the rotary *drill string*. It is fitted into and passes through the rotary table and is turned by it during drilling, thereby transmitting the rotary motion of the table to

the drill pipe

**Kenoran orogeny** (Ke-nor'-an) A name proposed by Stockwell (1964) for a time of plutonism, metamorphism, and deformation during the Precambrian of the Canadian Shield (especially in the Superior and Slave provinces), dated radiometrically at 2390-2600 m.y. ago, or at the end of the Archean of the present Canadian Classification. It is synonymous with *Algoman orogeny* of Minnesota.

**keratophyre** (ker-a'-to-phvre) A name originally applied to trachytic rocks containing highly sodic feldspars, but now more generally applied to all salic lavas and dike rocks characterized by containing albite or albite oligoclase, chlorite, epidote, and calcite.

**kernite** (kern'-ite) A colorless to white monoclinic mineral  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 4\text{H}_2\text{O}$ .

**kerogen** (ker'-o-gen) The solid, bituminous mineraloid substance in oil shales which yields oil when the shales undergo destructive distillation.

**kerogen shale** *oil shale*.

**kettle** 1 A depression in glacial drift, esp. in outwash and a kame field, formed by the melting of a detached block of stagnant ice that was buried in the drift. It often contains a lake or swamp; Thoreau's Walden Pond is an example. 2 A *pothole* in a stream bed.

**kettle lake** A body of water occupying a *kettle*.

**Keweenaw** (Ke-wee-naw'-an) A

provincial series of the Precambrian in Michigan and Wisconsin.

**key** 1 A *cay*, esp. one of the coral islets off the southern coast of Florida. 2 A *legend* on a map. 3 An analytic device or arrangement for identifying plant or animal forms.

**key bed** 1 A bed with sufficiently distinctive characteristics to make it easily identifiable in correlation. 2 A bed the top or bottom of which is used as a datum in making structure-contour maps. See also *key horizon*. Syn. *marker bed*.

**key horizon** 1 The top or bottom of an easily recognized, extensive bed or formation that is so distinctive as to be of great help in stratigraphy and structural geology. 2 A term that is used interchangeably with *key bed*.

**K-feldspar** *potassium feldspar*.

**kick** 1 *arrival*. 2 A surge against the normal fluid circulation in an oil well, caused by the formation pressure in the well exceeding the pressure exerted by the drilling mud.

**kidney ore** A variety of hematite, occurring in compact kidney-shaped masses.

**kieselguhr** (kie'-sel-guhr [key'-zi-goor]) German name for *diatomite*.

**kieserite** (kie'-ser-ite [key'-zer-ite]) A white monoclinic mineral  $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ . It occurs in saline residues.

**Killarney Revolution** (Kil-lar'-ney) A name proposed by Schuchert in 1924 for a supposed ma-

jor orogeny at the end of Precambrian time in North America. No notable tectonic events are now known to have occurred in this part of North America at the end of the Precambrian. The term is obsolete, and should be abandoned.

**kimberlite** (kim'-ber-lite) An alkalalic *peridotite* containing abundant phenocrysts of olivine (commonly altered to serpentine or carbonate) and phlogopite (commonly chloritized), in a fine-grained groundmass of calcite, second-generation olivine, and phlogopite; with accessory ilmenite, serpentine, chlorite, magnetite, and perovskite. The name is derived from Kimberley, South Africa, where the rock contains diamonds. See also: *blue ground*; *yellow ground*.

**Kinderhookian** (Kin-der-hook'-i-an) Lowermost Mississippian of North America.

**kindred** (kin'-dred) *rock association*.

**kinetic metamorphism** (ki-net'-ic) The deformation of rocks without accompanying chemical reconstitution or recrystallization to form new minerals.

**kingdom** 1. The highest category in the hierarchy of classification of animals and plants that is subject to formal regulation in nomenclature. 2. Any one of the three major divisions into which all natural objects are traditionally classified, viz. animal kingdom, plant kingdom, mineral kingdom.

**kink fold** A fold with planar limbs

and sharp angular hinge. Cf: *chevron fold*.

**klint** 1. An exhumed fossil *bioherm* or coral reef, forming a knob or ridge because the surrounding rocks have been eroded away. Cf: *tepee butte*. 2. A term used in Denmark and Sweden for a precipice, esp. a cliff along the shore of the Baltic Sea.—Pl: *klintar*.

**klintite** (klint'-ite) Biohermal limestone, particularly the massive core; the rock composing a *klint*.

**klippe** (klip'-pe) An isolated mass of rock that is an erosional remnant or outlier of a *nappe*. Pl: *klippen*.

**knickpoint** Any interruption or break of slope; esp a point of abrupt change or inflection in the longitudinal profile of a stream or of its valley. Etymol: German *Knickpunkt*, "bend point". Syn: *nickpoint*; *knickpunkt*. See also: *interrupted profile*.

**knob** A rounded hill or mountain, especially an isolated one. Local in the southern U.S.

**knob-and-basin topography** *knob-and-kettle topography*.

**knob-and-kettle topography** An undulating landscape in which a disordered assemblage of knolls, mounds, or ridges of glacial drift is interspersed with irregular depressions, pits, or kettles that are commonly undrained and may contain swamps or ponds. See also: *hummocky moraine*.

Syn: *knob-and-basin topography*.

**knoll** 1. A submerged elevation of rounded shape rising from the

ocean floor, but less prominent than a seamount. 2. A small rounded hill.

**komatiite** (ko-mat'-i-ite) An igneous suite of basaltic and ultramafic lavas and associated rocks. They commonly exhibit *spinifex texture*. The name is from the Komati River, South Africa.

**kratogen** (krat'-o-gen) An early variant of *craton*.

**KREEP** An acronym for a basaltic lunar rock type, first found in Apollo 12 fines and breccias, characterized by an unusually high content of potassium (K), rare-earth elements (REE), phosphorus (P), and other trace elements. The material is distinctly different from the iron-rich *mare* basalts.

**kuroko deposit** (ku-ro'-ko) A type of massive base-metal sulfide deposit in Japan. Kuroko deposits are typically zoned and stratabound. They are volcanogenic deposits of Miocene age, precipi-

tated on the sea floor adjacent to fumaroles or hot springs on the flanks of submarine dacite domes during the late stages of explosive felsic volcanic cycles. Cf: *Cyprus-type deposit*.

**kurtosis** (kur-to'-sis) The peakedness or flatness of the graphic representation of a statistical distribution; specif. a measure of the peakedness of a *frequency distribution*. Various coefficients of kurtosis have been devised in an attempt to assign genetic significance to sediment distributions. Cf: *skewness*.

**kyanite** (ky'-a-nite) A blue or light-green triclinic mineral,  $Al_2SiO_5$ . It is trimorphous with andalusite and sillimanite. Kyanite occurs in long bladed crystals and crystalline aggregates in schists, gneisses, and granite pegmatites; it forms at medium temperatures and high pressures in regionally metamorphosed sequences. It is used in the manufacture of refractories. Also spelled: *cyanite*.

# L

**labile** (la'-bile) 1. Said of rocks and minerals that are easily decomposed. 2. Said of unaltered and readily decomposable plant and animal products, e.g. fat, oil, or protein, in peat and sapropel.

**labradorescence** (lab'-ra-dor-es'-cence) Flashes of iridescence of a single bright hue that change gradually as a mineral or gemstone is moved about in reflected light, caused by internal structures that reflect only certain colors; specif. the light-interference effect exhibited by labradorite and set up in thin plates of feldspar (produced by repeated twinning or by exsolution), resulting in a series of vivid colors (usually brilliant blue or green) spread over large areas.

**labradorite** (lab'-ra-dor-ite) 1. A feldspar mineral of the plagioclase series having approximately equal proportions of sodium and calcium. It is common in igneous rocks of intermediate to low silica content. 2. A name applied by French petrologists to light-colored labradorite-rich basalt and by Soviet petrologists to a light-colored gabbro or norite.

**laccolith** (lac'-co-lith) A concordant igneous intrusion that has domed the overlying rocks and has a known or assumed flat floor and a postulated dike-like feeder beneath its thickest point. It is roughly circular in plan, less than five miles in diameter, and from a

few feet to several hundred feet in thickness. See also: *bysmalith*.

**lacuna** (la-cu'-na) 1. A chronostratigraphic unit representing a gap in the record, specif. the missing interval at an unconformity. Cf: *hiatus*. 2. A pore, opening, hole, or gap in various invertebrate organisms.

**lacustrine** (la-cus'-trine) 1. Pertaining to, produced by, or inhabiting a lake or lakes, e.g. "lacustrine sands" or a "lacustrine fauna". 2. Said of a region characterized by lakes.—Cf: *limnic*. Syn: *lacustral*; *lacustrian*.

**ladder vein** One of a series of mineral deposits in transverse, roughly parallel fractures that have formed along foliation planes perpendicular to the walls of a dike during its cooling, or along shrinkage joints in basaltic rocks or dikes. Syn: *ladder reef*.

**lag** 1. *lag gravel*. 2. The time between the formation of potential sediment by weathering and its removal and deposition. 3. The delay between the arrival of a seismic signal at a detector and the response.

**lag gravel** 1. A residual accumulation of coarse rock fragments on a surface after the finer material has been blown away by winds. See also: *desert pavement*. 2. Coarse-grained material that is rolled or dragged along the bottom of a stream at a slower rate than the finer material, or is left behind after currents have washed away the finer material.—Syn: *lag*; *lag deposit*.



**lagoon** (la-*goon'*) 1. A sound, channel, or bay, partly or completely separated from the sea by a reef or barrier island, esp. the water between an offshore coral reef and the mainland. 2. A shallow body of fresh water cut off from a lake by a barrier, e.g. a lake behind a dune. 3. The shallow body of water enclosed within an atoll. 4. Any shallow artificial pond or other water-filled excavation, as for the oxidation of sewage or for a decorative purpose. **lagoon cycle** The sequence of events, and the interval of time, involved in the filling of a lagoon with sediments followed by erosion by wave action.

**laguna** (la-gu'-na) 1. *lagoon*. 2. A term used in the southwestern U.S. for a shallow ephemeral lake in a *bolson*. Etymol. Spanish, "pond, small lake".

**lahar** (la-har') 1. A landslide or mudflow of pyroclastic material on the flank of a volcano; also, the deposit produced. Etymol. Indonesian.

**lake** Any inland body of standing water, larger and deeper than a pond. The term includes an expanded part of a river, a reservoir behind a dam, and a lake basin formerly or intermittently covered by water.

**lake plain** 1. The nearly level surface marking the floor of an extinct lake, filled in by well-sorted deposits from inflowing streams. 2. A flat lowland or a former lake bed bordering an existing lake. See also: *lake terrace*.

**lake rampart** A conspicuous ridge of coarse material along a lake shore, produced by shoreward movement of lake ice, as by winds, waves, or currents, and esp. by expansion of ice against yielding lake-shore deposits. Examples occur along the shores of the Great Lakes. See also: *walled lake*. Syn: *ice-push ridge*.

**lake terrace** A narrow shelf, partly cut and partly built, produced along a lake shore in front of a nip or line of low cliffs, and later exposed when the water level falls. See also: *lake plain*.

**Lamarckism** (La-marck'-ism) A 19th-century theory of evolution stating that changes in the environment cause structural changes in an organism by inducing new or increased use of organs or parts as a result of adaptive modification or greater development, and also cause disuse and eventual atrophy of other parts, and that these changes are passed on to offspring. This theory is named after the French naturalist J. B. de Monet Lamarck (1744-1829).

**Lambert azimuthal equal-area projection** An azimuthal map projection having its pole at the center of the area mapped, the azimuths of great circles radiating from this pole (center) and being truly represented on the map but the scale along these lines so varying with distance from the center that an equal-area projection is produced. The projection is useful for representing a single hemisphere or continental masses, but

extreme distortion of areas is encountered near the map periphery. See also *Schmidt projection*.

**Lambert conformal conic projection** A conformal conic map projection on which all meridians are represented by equally spaced straight lines that radiate from a common point outside the map limits and the parallels (of which one or two are standard parallels along which the scale is exact) are represented by circular arcs having this common point for a center and intersecting the meridians at right angles. The scale is the same in every direction at any point on the map, but increases north and south from the standard parallel(s), where there are two standard parallels, the scale is too small between them and too large beyond them. The projection is used for maps of middle latitudes.

**lamella** (la-mel'-la) 1 A thin scale, lamina, or layer, e.g. one of the units of a polysynthetically twinned mineral, such as plagioclase. 2 An organ, process, or part of an organism resembling a leaf or thin plate, e.g. a primary lamella of a brachiopod. —Pl *lamellae*

**lamellar** (la-mel'-lar) Composed of or arranged in lamellae, disposed in layers like the leaves of a book. **lamellar flow** Flow of a liquid in which layers glide over one another. Cf *laminar flow*.

**lamellibranch pelecypod**

**lamina** (lam'-i-na) 1 The thinnest recognizable layer in a sediment

or sedimentary rock, differing from other layers in color, composition, or particle size; commonly 0.05 to 1.00 mm thick. Syn *lamination*. 2 A thin plate-like or scalelike structure in an organism. —Pl *laminae*

**laminar** (lam'-i-nar) Consisting of arranged in, or resembling laminae, e.g. "laminar structure" produced by alternation of thin sedimentary layers of differing composition.

**laminar flow** 1 Water flow in which the stream lines remain distinct and the flow direction at every point remains unchanged with time. It is characteristic of the movement of ground water. Cf *turbulent flow*. **lamellar flow** Syn *streamline flow*. 2 A type of glacier flow in which the surface, bed, and flow vectors are all parallel.

**laminated quartz** (lam'-i-nat-ed) Vein quartz containing slabs, blades or laminar films of other material.

**lamination** (lam-i-na'-tion) 1 *lamina*. 2 The formation of laminae. 3 The state of being laminated, specif. the finest stratification, typically shown by shale and fine-grained sandstone.

**lamprophyre** (lam'-pro-phyre) A group of dike rocks in which dark minerals occur both as phenocrysts and in the groundmass and light minerals occur in the groundmass. Essential constituents are biotite, hornblende, pyroxene, and feldspar or feldspathoids. Most lamprophyres

are highly altered. They are commonly associated with *carbonatites*. Cf *camptonite*. Adj *lamprophyric*.

**lamp shell** A syn. of *brachiopod*, esp. a Mesozoic form (terebratuloid), which resembles an ancient Roman pottery lamp.

**land bridge** A land connection between continents or landmasses, often subject to temporary or permanent submergence, that permits the migration of organisms, e.g. the Bering Land Bridge.

**landform** One of the multitudinous features that taken together make up the surface of the earth. It includes broad features, such as plain, plateau, and mountain, and also minor features, such as hill, valley, slope, canyon, arroyo, and alluvial fan.

**landmass** A part of the continental crust lying above sea level, considered as a unit without regard to size or relief.

**land-pebble phosphate** A term used in Florida for a *pebble phosphate* occurring as pellets, pebbles, and nodules in gravelly beds a few feet below the ground surface. It is extensively mined. Cf *river-pebble phosphate*. Syn. *matric*.

**Landsat** An unmanned earth-orbiting NASA satellite that transmits multispectral images in the 0.4 to 11  $\mu\text{m}$  region to earth receiving stations. It was formerly called Earth Resource Technology Satellite, or ERTS.

**landslide** A general term for a wide variety of processes and land-

forms involving the downslope movement, under gravity, of masses of soil and rock material. There is a broad range of landslide morphology, rates, patterns of movement, and scale. Types include rockfall, mudflow, slump, and many others.

**land-tied island** A *tied island* connected with the mainland by a *tombolo*.

**langbeinite** (lang'-bein-ite [lang'-by-nite]) A colorless to reddish isometric evaporite mineral,  $\text{K}_2\text{Mg}_2(\text{SO}_4)_3$ . It is much used in the fertilizer industry as a source of potassium compounds.

**lapidary** (lap'-i-dar-y) 1. One who cuts and polishes gems or other stones. 2. The art of cutting gems. **lapilli** (la-pil'-li) Pyroclastics in the general size range of 2 to 64 mm. Cf *cinders*.

**lapis lazuli** (lap'-is laz'-u-li) 1. A granular crystalline rock composed essentially of lazurite and calcite; it has a rich blue color and is used as a semiprecious stone. 2. An old name for lazurite, still used esp. for the gem variety.

**lap-out map** A map showing the areal distribution of formations immediately overlying an unconformity. Syn. *worm's-eye map*.

**lapse rate thermal gradient.**

**Laramide orogeny** (Lar'-a-mide) A time of deformation, typically recorded in the eastern Rocky Mountains of the United States, whose several phases extended from late Cretaceous until the end of the Paleocene. Intrusives and accompanying ore deposits em-

placed about this time in the mountain states are commonly called Laramide. The orogeny is named for the Laramie Formation of Wyoming and Colorado, probably a synorogenic deposit.

**Larsen variation diagram** Weight per cent of each oxide constituent in a rock analysis is plotted as the ordinate against the "abscissa position" defined as  $1/3 \text{ SiO}_2 + \text{K}_2\text{O} + \text{FeO} + \text{MgO} + \text{CaO}$ ; a smooth curve is drawn through the points representing a given constituent in a series of analyses.

**larvikite** (lar'-vik-ite) An alkalic syenite with abundant phenocrysts of feldspar. Augite is the chief mafic mineral and apatite may be abundant as an accessory mineral.  
**late** Occurring near the end of a segment of time. The adjective is applied to the name of an era, period, or epoch to indicate relative time designation, and corresponds to *upper* as applied to the name of the equivalent time-stratigraphic unit, e.g. rocks of an Upper Jurassic batholith were intruded in Late Jurassic time. The initial letter is capitalized to indicate a formal subdivision (e.g. "Late Devonian") and is lower-cased to indicate an informal subdivision (e.g. "late Miocene"). Cf. *middle*, *early*.

**lateral accretion** (lat'-er-al) Lateral growth of a sedimentary deposit, e.g. the building-up of the inner bank of a stream meander by deposition of material brought there by rolling or pushing along the bottom. Cf. *vertical accretion*.

**lateral erosion** The action of a meandering stream as it swings from side to side, impinging against and undercutting its banks; the process results in *lateral planation*.

**lateral migration** Movement of oil or gas through permeable zones parallel to the stratification.

**lateral moraine** 1 A low ridgelike moraine carried on, or deposited at, the side of a mountain glacier. It is composed chiefly of rock fragments loosened from the valley walls by glacial abrasion and plucking, or fallen onto the ice from the bordering slopes. 2 An end moraine built along the side margin of a glacial lobe occupying a valley. Cf. *flanking moraine*.

**lateral planation** The reduction of the land in an interstream area to a plain or a nearly flat surface by the *lateral erosion* of a meandering stream; the creation and development by a stream of its flood plain.

**lateral secretion** The theory that the contents of a vein or lode are derived from the adjacent wall rock.

**laterite** (lat'-er-ite) A highly weathered red subsoil or material rich in secondary oxides of iron, aluminum, or both, nearly devoid of bases and primary silicates, and commonly with quartz and kaolinite. It develops in a tropical or forested warm to temperate climate, and is a residual product of weathering. Cf. *Latosol*.

**latite** (la'-tite) A porphyritic extrusive rock having phenocrysts of

plagioclase and potassium feldspar in nearly equal amounts, little or no quartz, and a finely crystalline to glassy groundmass, the extrusive equivalent of *monzonite*. Latite grades into *trachyte* with an increase in the alkali feldspar content, and into *andesite* or *basalt*, depending on the presence of sodic or calcic plagioclase, as the alkali feldspar content decreases. It is usually considered synonymous with *trachyandesite* and *trachybasalt*, depending on the color.

**latitude** (lat'-i-tude) Angular distance of a point on the earth's surface north or south of the equator, measured along a meridian, the equator being latitude zero degrees, the north pole lat. 90°N and the south pole lat. 90°S. Cf. *longitude*.

**Latosol** (Lat'-o-sol) A great group of zonal soils characterized by deep weathering and abundant hydrous-oxide material. They are developed under forested humid tropical conditions. Cf. *laterite*.

**lattice-preferred orientation** (lat'-tice-pre-ferred') The preferred orientation of crystallographic axes or planes. In metamorphic rocks, it results from crystal gliding and/or dynamic recrystallization and is dependent on the mineral structure and on the pressure, temperature, and stress during deformation. In igneous rocks, it is mainly related to the original shape of the crystals during settling or flow. Cf. *shape-preferred orientation*.

**Laurasia** (Lau-ra'-sia) The proto-continent of the Northern Hemisphere, corresponding to *Gondwana* of the Southern Hemisphere, from which the present northern continents have been derived by *continental displacement*. Etymol. a combination of *Laurentia*, a paleogeographic term for the Canadian Shield and its surroundings, and *Furassia*. Cf. *Pangea*.

**laurdalite** (laur'-dal-ite) An alkalic *syenite* containing more than 10 percent modal feldspathoids and characterized by porphyritic texture.

**Laurentian** (Lau-ren'-tian) A name that is widely and confusingly used for granites and orogenies of Precambrian age in the Canadian Shield. It is named for the Laurentian Highlands of eastern Canada, where Logan in 1863 recognized the Laurentian granites, now dated radiometrically at about 1000 m.y. In 1885 Lawson applied the name to much older granites, from which Schuchert later derived his Laurentian "Revolution" that was supposed to have terminated the Archeozoic. It has been suggested that the term Laurentian be restored to Logan's original meaning.

**lava fluid** rock that issues from a volcano or fissure, also, the same material solidified by cooling.

**lava blister** A small hollow steep-sided swelling raised on the surface of a lava flow by gas bubbles puffing up the viscous crust of the

flow.

**lava cascade** A cascade of fluid, incandescent lava, formed when a lava river passes over a cliff or over a precipitous part of its course.

**lava cave** *lava tube*.

**lava cone** A volcanic cone built of lava flows, usually basaltic, that were very mobile at the time of eruption; it resembles a miniature shield volcano.

**lava dome** 1. A dome-shaped mountain of solidified lava in the form of many individual flows, formed by the extrusion of highly fluid lava, e.g. Mauna Loa, Hawaii. Cf. *volcanic dome*. 2. *shield volcano*.

**lava flow** A lateral, surficial outpouring of molten lava from a vent or fissure; also, the solidified body of rock that is so formed.

**lava fountain** A jet of incandescent lava, shot into the air as magma reaches the surface by the hydrostatic pressure on the liquid and the expansion of gas bubbles forming in it. Fountains usually range from about 10 to 100 m in height, but occasionally reach 300 m. They are characteristic of *Hawaiian-type eruptions*.

**lava plain** A broad stretch of level or nearly level land, usually many hundreds of square kilometers in extent, underlain by a relatively thin succession of lava flows, most of which are basaltic and the product of *fissure eruptions*.

**lava plateau** A broad, elevated tableland or flat-topped highland, usually many hundreds or thou-

sands of square kilometers in extent, underlain by a thick succession of lava flows, most of which are tholeiitic basalts and the product of fissure eruption.

**lava shield** *shield volcano*.

**lava tube** A hollow space beneath the surface of a solidified lava flow, formed by the withdrawal of molten lava after the formation of the surficial crust. Syn: *lava cave*; *lava tunnel*.

**lava tunnel** *lava tube*.

**law** In science, a formal statement of the invariable and regular manner in which natural phenomena occur under given conditions; e.g. the "law of superposition".

**law of constancy of interfacial angles** The statement in crystallography that the angles between corresponding faces on different crystals of one substance are constant.

**law of crosscutting relationships** A stratigraphic principle whereby relative ages of rocks can be established; a rock (esp. an igneous rock) is younger than any other rock across which it cuts.

**law of equal declivities** Where homogeneous rocks are maturely dissected by consequent streams, all hillside slopes of the valleys cut by the streams tend to develop at the same slope angle, thereby producing symmetrical profiles of ridges, spurs, and valleys.

**law of faunal assemblages** A general law of geology. Similar assemblages of fossil organisms (faunas or floras) indicate similar geologic ages for the rocks that contain

them

**law of faunal succession** A general law of geology Fossil organisms (faunas and floras) succeed one another in a definite and recognizable order, each geologic formation having a different total aspect of life from that in the formations above it and below it, or, the relative age of rocks can be determined from their fossil content

**law of homonymy** A principle in taxonomy stating that any name that is a junior homonym of another name must be rejected and replaced

**law of nature** A generalization of science representing an intrinsic orderliness of natural phenomena or their necessary conformity to reason Syn *natural law*

**law of original continuity** A general law of geology A water laid stratum, at the time it was formed, must continue laterally in all directions until it thins out as a result of nondeposition or until it abuts against the edge of the original basin of deposition

**law of original horizontality** A general law of geology Water laid sediments are deposited in strata that are horizontal or nearly horizontal, and parallel or nearly parallel to the earth's surface

**law of priority** A principle in taxonomy stating that nomenclature of a taxonomic group is based on priority of publication Thus the valid name of a genus or species can be only that name under which it was first designated

**law of rational indices** The statement in crystallography that crystal faces make simple rational intercepts on suitable crystal axes, i.e. the axes of reference or the three axes forming the edges of the unit cell of each crystal lattice

**law of reflection** The statement in physics that the angle between the reflected ray and the normal to the reflecting surface is the same as the angle between this normal and the incident ray, provided the wave travels with the same velocity as the incident wave

**law of refraction** The statement in physics that when a wave crosses a boundary between two isotropic substances, the wave normal changes direction in such a manner that the sine of the angle of incidence between wave normal and boundary normal divided by the velocity in the first medium equals the angle of refraction divided by the velocity in the second medium Syn *Snell's law*

**law of stream gradients** A general law expressing the inverse geometric relation between *stream order* and the mean stream gradient of a given order in a given drainage basin

**law of superposition** A general law upon which all geologic chronology is based In any sequence of sedimentary strata (or of extrusive igneous rocks) that has not been overturned the youngest stratum is at the top and the oldest at the base, each bed is younger than the bed beneath, but older than the bed above it The law

was first clearly stated by Steno in 1669

**law of universal gravitation** The statement that every mass particle in the universe attracts every other mass particle with a force directly proportional to the product of the two masses and inversely proportional to the square of the distance between them, the direction of the force being in the line joining the two particles. The law applies only to particles, and not to bodies of finite size

**layer** A bed or stratum of rock

**layer depth** In the ocean, the depth to the top of the *thermocline*, i.e., to the bottom of the *mixed layer*

**layering** (lay'-er-ing) 1 A tabular succession of different components in igneous or metamorphic rocks, or the formation of layers in a particular rock, e.g. in plutonic rocks as a result of crystal settling in magma "Layering" is preferable to *banding*, as it implies three dimensions rather than two 2 *stratification*.

**lazulite** (laz'-u-lite) An azure-blue to violet-blue mineral ( $\text{Mg, Fe}^{+3}\text{Al}_2(\text{PO}_4)_2(\text{OH})_2$ ). Not to be confused with *lazurite*

**lazurite** (laz'-u-rite) An intense blue or violet-blue feldspathoid mineral of the sodalite group ( $\text{Na,Ca}_{7-8}(\text{Al,Si})_{12}(\text{O,S})_{24}(\text{SO}_4\text{Cl}_2(\text{OH})_2)_2$ ). It is the principal constituent of *lapis lazuli*. Not to be confused with *lazulite*.

**leachate** A solution obtained by leaching e.g. water that has percolated through soil containing soluble substances and that con-

tains certain amounts of these substances in solution

**leaching** 1 The dissolution of soluble constituents from a rock or orebody by the natural action of percolating water 2 The removal in solution of mineral salts or organic matter from an upper to a lower soil horizon by the action of percolating water, either naturally (by rainwater) or artificially (by irrigation) Cf *eluviation* 3 The extraction of soluble metals or salts from an ore by means of slowly percolating solutions e.g. the separation of gold by treatment with a cyanide solution

**lead** 1 A soft heavy malleable isometric mineral, the native metallic element Pb. Lead rarely occurs in the native form, being found mostly in combinations, esp. galena. Pron *led* 2 A syn of *lode*, also a placer deposit. Pron *lead* 3 A long narrow belt of ocean water through sea ice, navigable by surface vessels. Pron *lead* 4 A syn of *time lead*. Pron *lead*

**lead glance galena**

**lead-uranium ratio** (lead-u-ra'-ni-um) The ratio of lead-206 to uranium-238 and/or lead-207 to uranium-235, formed by the radioactive decay of uranium within a mineral. The ratios are frequently used as part of the *uranium-thorium-lead age method* of computing the geologic age of a rock or mineral

**league** 1 Any of various linear units of distance, ranging from about 2.42 to 4.60 statute miles 2



Any of various units of land area equal to a square league, esp. an old Spanish unit equal to 4428 acres in Texas or 4439 acres in California.

**lean** *low-grade*.

**lean clay** A clay of relatively low plasticity. Ant: *fat clay*.

**lease** A contract between a landowner and another, granting the latter the right to search for and produce oil or mineral substances upon payment of an agreed rental, bonus, and/or royalty.

**least-time path** *minimum-time path*.

**lectostratotype** (lec'-to-strat'-o-type) A stratotype selected later in the absence of an adequately designated original stratotype.

**lectotype** (lec'-to-type) A *syntype*, chosen if needed after the original description, to take the place of the *holotype*.

**ledge** 1. A narrow shelf or projection of rock, longer than wide, formed on a rock wall or cliff face.

2. A rocky outcrop; solid rock. 3. An underwater ridge of rocks, esp. near the shore; also, a near-shore reef. 4. A quarry exposure or natural outcrop of a mineral deposit.

**lee** *n.* The side of a hill, dune, or other prominent object that is sheltered or turned away from the wind.—*adj.* Said of a side or slope of a hill or knob that faces away from an advancing glacier or ice sheet and is relatively protected from its abrasive action. Ant: *stoss*.

**left-handed separation** *left-lateral*

*separation*.

**left-lateral fault** (left-lat'-er-al) A fault on which the displacement is *left-lateral separation*. Syn: *sinistral fault*.

**left-lateral separation** Displacement along a fault such that, in plan view, the side opposite the observer appears displaced to the left Cf: *right-lateral separation*. Syn: *left-handed separation*.

**legal geology** *forensic geology*.

**legend** (leg'-end) Explanation of the symbols and patterns shown on a map or diagram. Syn: *key*.

**Lemberg solution** (Lem'-berg) An aqueous solution of logwood extract and  $\text{AlCl}_3$  which produces a violet stain on calcite but leaves dolomite unchanged.

**lens** *n.* A body of ore or rock that is thick in the middle and thin at the edges, like a doubly convex lens. *Adj.*: *lenticular*. See also: *lenticil*.—*v.* To disappear laterally; e.g. a unit is said to "lens out" within a mapped area.

**lensing** The thinning-out of a stratum in one or more directions; its lateral disappearance.

**lenticular** (len-tic'-u-lar) 1. Resembling in shape the cross section of a lens, esp. of a double-convex lens. 2. Pertaining to a stratigraphic lens or lenticil.

**lenticil** (len'-til) 1. A lens-shaped rock body. 2. A minor rock-stratigraphic unit, a subdivision of a formation similar in rank to a *member*, having relatively small geographic extent and thinning out in all directions. Cf: *tongue*.

**Leonardian** (Leo-nar'-di-an) Up-

per series of the Lower Permian of North America

**lepidoblastic** (lep'-i-do-blas'-tic)

Pertaining to the texture of a foliated or schistose rock that is due to the parallel orientation during recrystallization of minerals with a flaky or scaly habit, e.g. mica, chlorite.

**lepidodendrid** (lep'-i-do-den'-drid)

n An arborescent lycopsid well known from Carboniferous deposits —adj Pertaining to the genus *Lepidodendron* or to related genera —Cf *sigillarian*.

**lepidolite** (le-pid'-o-lite) A mineral

of the mica group  $K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$ . It commonly occurs in rose or lilac-colored masses made up of small scales, as in pegmatites. Syn *lithium mica*.

**lepidomelane** (lep-i-do'-mel-ane) A

black variety of biotite with a high content of ferric iron

**leptothermal** (lep-to-ther'-mal)

Said of a hydrothermal mineral deposit formed at temperature and depth conditions intermediate between *mesothermal* and *epithermal*, also, said of that environment

**leucite** (leu'-cite) A white or gray

mineral of the feldspathoid group,  $KAlSi_3O_8$ . It is an important rock-forming mineral in alkalic rocks (esp. lavas), and usually occurs in trapezohedral crystals with a glassy fracture

**leucocratic** (leu-co-cratic'-ic) Light-

colored, applied to igneous rocks containing less than 30% mafic minerals. Cf *melanocratic*, *mesocratic*.

**leucoxene** (leu'-cox-ene) A general term for fine-grained, opaque, whitish alteration products of ilmenite, commonly consisting mostly of rutile and partly of anatase or sphene, and occurring in some igneous rocks. The term has also been applied to designate a variety of sphene.

**levee** (lev'-ee) 1 *natural levee*. 2

An artificial embankment along a watercourse or an arm of the sea, to protect land from flooding. 3 A landing place along a river, a pier or quay. 4 An embankment of sediments on one or both sides of a submarine canyon or deep-sea channel, it is similar to a natural levee on land.

**levee delta** A delta having the form of a long narrow ridge, resembling a natural levee.

**leveling** (lev'-el-ing) Determining the comparative altitude of different points on the earth's surface, usually by sighting through a leveling instrument at one point to a level rod at another point. Also, the finding of a horizontal line or the establishing of grades by means of a level.

**leveling instrument** An instrument for establishing a horizontal line of sight, usually by means of a spirit level or a pendulum device. It is used, with a level rod, to determine differences in elevation between two separated points on the earth's surface.

**level of zero amplitude** The maximum depth below the earth's surface reached by seasonal temperature changes.

**level rod** A straight rod or bar, with a flat face graduated in plainly visible linear units with zero at the bottom, used in measuring the vertical distance between a point on the earth's surface and the line of sight of a leveling instrument that has been adjusted to a horizontal position. Syn: *rod*; *leveling rod*; *surveyor's rod*.

**level surface** A surface which at every point is perpendicular to the plumb line or the direction in which gravity acts.

**Lg wave** A short-period, higher-mode *surface wave*, with a group velocity of about 3.5 km/sec, that travels over long paths in the continental crust only. The "g" refers to the granitic layer. Cf: *Rg wave*.

**lick salt lick**.

**Liesegang rings** (Lie'-se-gang [Lee'-se-gang]) Secondary, nested rings or bands caused by rhythmic precipitation within a fluid-saturated rock.

**life assemblage** *biocoenosis*.

**life cycle** The phases, changes, or stages an organism passes through during its lifetime. Syn: *ontogeny*.

**light mineral** A rock-forming mineral of a detrital sedimentary rock, having a specific gravity lower than a standard (usually 2.85); e.g. quartz, feldspar, calcite, dolomite, muscovite, feldspathoids. Cf: *heavy mineral*.

**light oil** Crude oil that has a high *API gravity* or *Baume gravity*. Cf: *heavy oil*.

**lightweight aggregate** An *aggregate* with a relatively low specific

gravity, e.g. pumice, volcanic cinders, expanded shale, foamed slag, or expanded perlite or vermiculite.

**lignite** (lig'-nite) A brownish-black coal that is intermediate in coalification between peat and sub-bituminous coal; consolidated coal with a calorific value less than 8300 BTU/lb, on a moist, mineral-matter-free basis. Cf: *brown coal*.

**limb 1.** That area of a fold between adjacent fold hinges. It may be planar or gently curved. Syn: *flank*. **2.** The outer edge of a lunar or planetary disk. **3.** The graduated margin of an arc or circle in an instrument for measuring angles. **4.** The graduated staff of a leveling rod.

**lime 1.** Calcium oxide or quicklime, CaO; also calcium hydroxide or hydrated lime, Ca(OH)<sub>2</sub>. **2.** A term sometimes misused for limestone, as in agricultural "lime" or in such oilfield expressions as "Big lime". **3.** It is also misused for calcium, as in "carbonate of lime" or "lime feldspar".

**lime feldspar** A misnomer for "calcium feldspar", i.e. *anorthite*.

**limestone** A sedimentary rock consisting chiefly of the mineral calcite (calcium carbonate, CaCO<sub>3</sub>), with or without magnesium carbonate. Common impurities include chert and clay. Limestone is the most important and widely distributed of the carbonate rocks and is the consolidated equivalent of limy mud, calcareous sand,

and/or shell fragments. It yields lime on calcination.

**limnetic** (lim-net'-ic) 1. Relating to the pelagic or open part of a body of fresh water. 2. Said of lake-dwelling organisms and communities that are free from direct dependence on the bottom or shore.—Syn: *limnic*.

**limnic** (lim'-nic) 1. Pertaining to a body of fresh water. Cf: *lacustrine*. 2. *limnetic*. 3. Said of coal deposits formed inland in fresh-water basins or peat bogs, as opposed to *paralic* deposits.

**limnobios** (lim-no-bi'-os) The life of the fresh-water environment.

**limnology** (lim-nol'-o-gy) The scientific study of fresh waters, especially of ponds and lakes. It deals with the physical, chemical, meteorological, and esp. biological and ecological conditions pertaining to such bodies of water.

**limonite** (li'-mo-nite) A field term for a group of brown amorphous hydrous ferric oxides. Limonite is a common secondary material, formed by weathering (oxidation) of iron-bearing minerals; it may also occur as a precipitate in bogs or lakes. It occurs as coatings, earthy masses, and in a variety of other forms, and is the coloring material of yellow clays and soils. Limonite is a minor ore of iron. See also: *bog iron ore*. Syn: *brown iron ore*.

**limy** 1. Containing a significant amount of lime or limestone; e.g. "limy soil". 2. Containing calcite; e.g. "limy dolomite" (a calcitic dolomite rock).

**Lindgren's volume law** The principle that during formation of ore by replacement, there is no change in rock volume or form. Syn: *volume law*.

**lineage** (lin'-e-age) A series of genera and species which form an evolutionary series, each one being ancestral to its successor in the geological sequence; a line of evolution.

**lineament** (lin'-e-a-ment) A linear topographic feature of regional extent that is believed to reflect crustal structure. Examples are fault lines, aligned volcanoes, and straight stream courses. Non-recommended syn: *linear*.

**linear** (lin'-e-ar) adj. Arranged in a line or lines, pertaining to the line-like character of some object or objects.—n. A nonrecommended syn. of *lineament*.

**linear element** A fabric element having one dimension that is much greater than the other two. Lineations are the common linear elements. Cf: *planar element*; *equant element*.

**lineation** (lin'-e-a'-tion) A general, nongeneric term for any linear structure in a rock, e.g. flow lines, stretched clasts, slickensides, preferred alignment of fossils, or axes of folds.

**line of section** A line on a map, indicating the position of a *profile section* or *cross section*.

**lingulid** (lin'-gu-lid) Any lingulacean brachiopod belonging to the family Lingulidae, characterized mainly by an elongate oval to spatulate outline and a biconvex

shell Their stratigraphic range is Silurian (possible Ordovician) to present The genus *Lingula* belongs to this family and has frequently been used loosely for any Ordovician species in the family

**linguoid ripple mark** (lin'-guoid)

An aqueous *current ripple mark* characterized by a tongue-shaped outline or having a barchanlike shape whose horns point into the current, it is best developed on the bottoms of shallow streams where it shows a highly irregular pattern with a wide variety of forms

**link** 1 An unbroken section of stream channel between forks 2 One of the 100 standard divisions of a surveyor's chain, measuring 7.92 inches in length

**linked veins** An ore-deposit pattern in which adjacent, more or less parallel veins are connected by diagonal veins or veinlets

**Linnaean** (Lin-nae'-an) Conforming to the principles of binomial nomenclature as advocated by the Swedish botanist Carl von Linne, who Latinized his name to Carolus Linnaeus

**Lipalian** (Li-pal'-i-an) A name formerly used for the interval of time represented by a widespread unconformity separating Precambrian and Cambrian strata

**liquefied natural gas** (liq'-ue-fied) Natural gas that has been cooled to about -160°C for shipment or storage as a liquid Liquefaction greatly reduces the volume of the gas, and thus decreases the cost of shipment and storage, even though high-pressure cryogenic

containers must be used Abbrev LNG

**liquefied petroleum gas** A compressed hydrocarbon gas obtained through distillation and usable as a motor fuel, for heating, or in certain industrial processes Abbrev LPG

**liquid flow** (liq'-uid) Movement of a liquid, generally one of low viscosity, involving laminar and/or turbulent flow Cf *viscous flow*, *solid flow*

**liquid immiscibility** A process of magmatic differentiation involving separation of the magma into two or more immiscible liquid phases, which are then separated from each other by gravity or other processes

**liquid limit** the water-content boundary between the semiliquid and the plastic states of a sediment, e.g. a soil It is one of the *Atterberg limits*. Cf *plastic limit*.

**liquidus** (liq'-ui-dus) The locus of points in a temperature-composition diagram representing the maximum solubility (saturation) of a solid component or phase in the liquid phase In a binary system it is a line, in a ternary system it is a curved surface, and in a quaternary system it is a volume

**lithic** (lith-ic) 1 A syn of *lithologic*, as in "lithic unit" 2 Said of a medium-grained sedimentary rock, and of a pyroclastic deposit, containing abundant fragments of previously formed rocks, also, said of such fragments 3 Pertaining to or made of stone e.g. "lithic artifacts" or "lithic architec

ture".

**lithic tuff** An indurated deposit of volcanic ash in which the fragments are composed of previously formed rocks, e.g. particles of sedimentary rock, pieces of earlier lavas in the same cone, or small bits of new lava that first solidify in the vent and are then blown out Cf *crystal tuff*

**lithification** (lith'-i-fi-ca'-tion) 1 The conversion of a newly deposited sediment into a solid rock, involving such processes as cementation, compaction, and crystallization. It may be concurrent with, soon after, or long after deposition Cf *consolidation*, *induration*. 2 The lateral termination of a coal bed owing to an increase in impurities.

**lithify** (lith'-i-fy) To change to stone, or to petrify, esp. to consolidate from a loose sediment to a solid rock.

**litho-** A prefix meaning "rock" or "stone"

**lithofacies** (lith'-o-fa'-cies) 1 A lateral, mappable subdivision of a designated stratigraphic unit, distinguished from adjacent subdivisions on the basis of lithology, a *facies* characterized by particular lithologic features. 2 The rock record of any sedimentary environment, including both physical and organic characteristics Cf *lithotopie*.

**lithofacies map** A *facies map* based on lithologic attributes, showing areal variation in the overall lithologic character of a given stratigraphic unit. The map

may emphasize the dominant, average, or specific lithologic aspect of the unit, and it gives information on the changing composition of the unit throughout its geographic extent.

**lithofraction** (lith'-o-frac'-tion) The breaking of rock fragments during transportation in streams or by wave action on beaches.

**lithogeochemistry** (lith'-o-ge'-o-chem'-is-try) The chemistry of the mineral fraction of the lithosphere, i.e. rocks, soils, and sediments Cf *biogeochemistry*, *hydrogeochemistry*.

**lithographic limestone** (lith'-o-graph'-ic) A compact, dense, homogeneous, exceedingly fine-grained limestone having a pale creamy yellow or grayish color and a conchoidal or subconchoidal fracture a *micritic*. It was formerly much used in lithography for engraving and the reproduction of colored plates.

**lithographic texture** A sedimentary texture of certain calcareous rocks, characterized by uniform particles of clay size and by an extremely smooth appearance resembling that of the stone used in lithography.

**lithohorizon** (lith'-o-ho-r'-zon) A surface of lithostratigraphic change or of distinctive lithostratigraphic character, pre-eminently valuable for correlation, commonly the boundary of a lithostratigraphic unit, though also often a lithologically distinctive horizon or very thin marker bed within a lithostratigraphic unit.

Cf *biohorizon*, *chronohorizon*.

**lithoidal** (lith-oid'-al) Said of the texture of some dense, microcrystalline igneous rocks, or of devitrified glass in which individual constituents are too small to be distinguished with the unaided eye

**lithologic** (lith-o-log'-ic) Adj of lithology Syn *lithic*

**lithology** (li-thol'-o-gy) 1 The description of rocks, esp in hand specimen and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size 2 The physical character of a rock -Adj *lithologic* Cf *petrology*

**lithophilic element** (lith'-o-phil'e) An element that is concentrated in the earth's silicate crust rather than in its mantle or core, and in the silicate rather than the metal or sulfide phases of meteorites Cf *chalcophile element*, *siderophile element*

**lithophysae** (lith-o-phy'-sae) Hollow bubblelike structures composed of concentric shells of finely crystalline alkali feldspar, quartz, and other minerals, found in certain silicic volcanic rocks, such as rhyolite and obsidian Sing *lithophysa*

**Lithosol** (Lith'-o-sol) An azonal group of soils characterized by shallow depth to bedrock and by recent and imperfect weathering. It usually develops on steep slopes

**lithosome** (lith'-o-some) A body of sediment deposited under uniform physicochemical conditions,

the lithostratigraphic equivalent of a *biosome*.

**lithosphere** (lith'-o-sphere) 1 The solid portion of the earth, as compared with the *atmosphere* and the *hydrosphere* 2 In plate tectonics, a layer of strength relative to the underlying *asthenosphere*. It includes the crust and part of the upper mantle and is of the order of 100 km in thickness

**lithostatic pressure** (lith-o-stat'-ic) *geostatic pressure*

**lithostratigraphic unit** (lith-o-strat-i-graph'-ic) A body of rock that consists dominantly of a certain lithologic type or combination of types, or has other unifying lithologic features. It may be igneous, sedimentary, or metamorphic, and it may or may not be consolidated. The critical requirement is a substantial degree of overall homogeneity. A lithostratigraphic unit has a binomial designation, preferably consisting of a geographic name from its type area combined with a descriptive term (e.g. Ohio Shale) or with the appropriate rank term (e.g. Rome Formation) Syn *rock stratigraphic unit*

**lithostratigraphy** (lith-o-stratig'-ra-phy) The element of stratigraphy that deals with the lithology of strata, their organization into units based on lithologic character, and their correlation

**lithothamnion** (lith-o-tham'-ni-on) A plant, an encrusting or nodular red calcareous alga, abundant in post-Jurassic rocks, and reported as a living form from considerable

depths and very cold waters. It is most abundant on the seaward edge of reef flats, where it acts as a cementing medium of some coral reefs.

**lithotype** (lith'-o-type) A visible band in humic coals, recognized by physical characteristics rather than botanical origin. The four lithotypes of banded bituminous coal are *vitrain*, *clarain*, *durain*, and *fusain*.

**lithozone** (lith'-o-zone) An informal term to indicate a body of strata that is unified in a general way by lithologic features but for which there is insufficient need or information to justify its designation as a formal unit. Syn: *litho-stratigraphic zone*.

**lit-par-lit** (lee-par-lee) adj. Having the characteristic of a layered rock, the laminae of which have been penetrated by numerous thin, parallel sheets and tongues of igneous material, usually granitic. Etymol: French, "bed-by-bed". Cf: *injection metamorphism*; *injection gneiss*.

**littoral** (lit'-to-ral) 1. Pertaining to the benthic environment or depth zone between high water and low water, or to the organisms of that environment. Syn: *intertidal*. 2. In an obsolete usage, pertaining to the depth zone between the shore and about 200 m.—Cf: *sub-littoral*; *supralittoral*.

**littoral cone** An ash or tuff cone built on a lava flow when it runs into a body of water, usually the sea. Such cones are the result of steam explosions that hurl into

the air large amounts of ash, lapilli, and small bombs derived from the new lava.

**littoral current** An ocean current caused by the approach of waves to a coast at an angle. It flows parallel to and near to the shore. See also: *littoral drift*. Syn: *long-shore current*.

**littoral drift** Material (such as shingle, gravel, sand, and shell fragments) that is moved along the shore by a *littoral current*. Syn: *longshore drift*.

**littoral shelf** A shallow nearshore terracelike part of a submerged lake bed, produced by wave erosion and deposition.

**living fossil** A modern animal or plant that has descended from a very ancient stock with comparatively little change.

**Llano** (lla'-no) A term for an extensive plain, with or without vegetation, applied esp. to the generally treeless plains of northern South America and the southwestern U.S. such as the Llano Estacado in west Texas. Etymol: Spanish, "staked plain".

**Llanoria** (Lla-nor'-i-a) One of the *borderlands* proposed by Schuchert in 1923, in this case south of North America, between the Ouachita geosyncline and the Gulf of Mexico. Modern knowledge of the substructure of the Gulf Coastal Plain and Gulf of Mexico virtually precludes the existence of this landmass.

**LNG** *liquefied natural gas*.

**load** 1. The material that is moved or carried by a natural transport-



ing agent, such as a stream, a glacier, or the wind; specif. *stream load*. 2. The quantity or amount of such material at any given time.—Syn: *sediment load*.

**load cast** A *sole mark*, usually less than a meter in diameter, formed as a low bulge, knob, or irregular protrusion of sand downward into soft clay, mud, or peat. It is more irregular than a *flute cast* and is not elongated in the current direction. See also: *flute*.

**load casting** The formation of a load cast or sole mark; also, the configuration of the underside of a stratum characterized by load casts.

**loaded stream** A stream that has all the sediment it can carry. A partly loaded stream is one carrying less than full capacity.

**loam** A rich, permeable soil composed of a mixture of clay, silt, sand, and organic matter.

**lobe** 1. A *glacial lobe*; also, a tongue-like extension of glacial drift beyond the main drift area. 2. *meander lobe*. 3. A curve in the suture line of a cephalopod shell with its convex side away from the aperture. Ant: *saddle*. 4. Any of several rounded protuberances in plant or animal fossils.

**lobefin** An extinct bony fish of the subclass Sarcopterygii, characterized by fins with an axial fleshy lobe and presumably by a paired swim bladder that functioned as a lung.

**local metamorphism** Metamorphism caused by a local process, e.g. contact metamorphism or

metasomatism near an igneous body. Cf: *regional metamorphism*.

**Locke hand level** A *hand level* with fixed bubble tube that can be used only for horizontal sighting.

**lode** A mineral deposit consisting of a zone of veins, veinlets, or disseminations; also, a mineral deposit in solid rock as opposed to a *placer* deposit. Syn. *lead* ("lead"). Cf: *vein*.

**lodestone** A piece of magnetite possessing polarity like a magnet or magnetic needle and hence one that, when freely suspended, will attract iron objects. Also spelled: *loadstone*.

**lode tin** Tin ore (cassiterite) occurring in veins, as distinguished from *stream tin*.

**lodgment till** A *basal till* commonly characterized by compact fissile structure and containing stones oriented with their long axes generally parallel to the direction of ice movement. Also spelled: *lodgement till*.

**loess** (approx: luss) A blanket deposit of buff-colored calcareous silt, homogeneous, nonstratified, weakly coherent, porous, and friable. A rude vertical parting allows it to stand in steep or vertical faces. Loess covers wide areas in northern Europe, eastern China, and the Mississippi Valley. It is considered to be windblown dust of Pleistocene age. Etymol: German.

**loess doli** A compound nodule or concretion of calcium carbonate found in loess and resembling a

doll, a potato, or a child's head.

Syn: *loess kindchen*.

**loessification** (loess'-i-fi-ca'-tion) Formation and development of loess.

**loess kindchen** *loess doll*

**Loewinson-Lessing classification** (Loe'-win-son-Iess'-ing)

A chemical classification of igneous rocks (into the four main types—acid, intermediate, basic, and ultrabasic) based on silica content

**log** A continuous record as a function of depth, usually graphic and plotted to scale on a narrow paper strip, of observations made on the rocks and fluids encountered in a well bore, e.g. *graphic log*, *caliper log*, *electric log*

**Logan's Line** A structural discontinuity along the northwestern edge of the Northern Appalachians, between complexly deformed rocks on the southeast and undisturbed rocks on the northwest. The name commemorates its discovery by Sir William Logan in 1863. For part of its distance the line is a major low-angle thrust fault, but to the northeast it is beneath the St. Lawrence Estuary and southward in Vermont it changes into a succession of discontinuous breaks. It is interpreted by many geologists as having been formed during the Taconic orogeny of early Paleozoic time.

**ogging** 1. The act or process of making or recording a *log*. 2. The method or technique by which subsurface formations are characterized relative to depth by measurements or observations on the

rocks of a borehole.

**lognormal distribution** (log-nor'-mal) A *frequency distribution* whose logarithm follows a normal distribution.

**log strip** A long, narrow piece of paper on which a log is plotted.

**longitude** (lon'-gi-tude) Angular distance between the meridian of a given place and the prime meridian of Greenwich, England (which has longitude zero degrees), measured east or west to a maximum value of 180 degrees. Cf: *latitude*

**longitude correction** The east-west corrections made to observed magnetic intensities by subtracting the earth's normal field

**longitudinal** (lon-gi-tu'-di-nal) Said of an entity that is extended lengthwise, esp. of a topographic feature that is oriented parallel to the general strike or topographic trend of a region. Ant: *transverse*

**longitudinal dune** A long, narrow sand dune, usually symmetrical in cross profile, oriented parallel with the direction of the prevailing wind; it commonly forms behind an obstacle in an area where sand is abundant and the wind is strong and constant. Such dunes may be a few meters high and up to 100 km long. See also: *seif*.

**longitudinal fault** A fault whose strike is parallel with that of the general structural trend of the region.

**longitudinal joint** A steeply dipping joint plane in a pluton that is oriented parallel to the lines of flow. Syn: *S-joint*.

**longitudinal profile 1** The profile of a stream or valley, drawn along its length from source to mouth, it is the straightened-out upper edge of a vertical section that follows the winding of the stream or valley. See also *thalweg*. Syn. *long profile*.

**longitudinal profile 2** A similar profile of a landform such as a pediment. **longitudinal section** A diagram drawn on a vertical or inclined plane and parallel to the longer axis of a given feature, e.g. a section drawn parallel to the strike of a vein, the length of a valley or the axis of a fossil. Cf. *cross section*.

**longitudinal stream** A stream that follows the strike of the underlying rocks.

**longitudinal valley** The valley of a *subsequent stream* developed parallel to the general strike of the underlying strata. Cf. *transverse valley*.

**longitudinal wave** *P wave*.

**longshore bar** A low sand ridge, built chiefly by wave action, occurring at some distance from and generally parallel with the shoreline, being submerged at least by high tides and typically separated from the beach by an intervening trough. Syn. *offshore bar*.

**longshore current** *littoral current*.

**longshore drift** *littoral drift*.

**longwall** Said of a method of underground mining in flat-lying strata, esp. of coal. Parallel entries are driven into the seam, to the limit of the block to be mined, from the end of these entries, workings are driven at right an-

gles in both directions. A long wall face is produced as these workings are widened back toward the point of entry. Working space is provided by timbers or other supports; the roof caves as mining progresses. Almost all of the coal or other desired mineral is recovered, in contrast to the *room and pillar* method.

**loop** A pattern of field observations that begin and end at the same point with a number of intervening observations. Such a pattern is useful in correcting for drift in gravity-meter observations for diurnal variation in magnetometer surveys and for faults or other cause of misclosure in seismic dip shooting.

**lopolith** (lop' o-lith) A large, concordant, typically layered igneous intrusion, of plano-convex or lenticular shape, that is sunken in its central part owing to sagging of the underlying country rock.

**Loran** (lō' ran) A hyperbolic radio location system similar to loran, in which two or more fixed transmitters emit continuous waves and the position of a mobile receiver in the resulting standing-wave pattern is determined by measuring the phase difference of the waves emanating from two of the transmitters. The useful range is about 200 nautical miles. A trade name. Etymol. *long-range accuracy*.

**loran** (lō' ran) Any of various long-range radio position fixing systems by which hyperbolic lines of position are determined by

measuring the difference in arrival times of synchronized pulse signals from two or more fixed transmitting radio stations of known geographic position. Loran fixes may be obtained at a range of 1400 nautical miles at night. Cf: *shoran*. Etymol: *long-range navigation*.

**lost circulation** The condition during *rotary drilling* when the drilling mud escapes into porous, fractured, or cavernous rocks penetrated by the borehole and does not return to the surface.

**lost river** 1. A dried-up stream in an arid region. 2. A stream that disappears underground in a *karst* region.

**louderback** (lou'-der-back) A remnant of a lava flow appearing in a tilted fault block and bounded by a dip slope. G. D. Louderback, an American geologist, used it as evidence of block faulting in a basin-and-range topography.

**Love wave** A type of *surface wave* having a horizontal motion that is shear or transverse to the direction of propagation. Its velocity depends only on density and rigidity modulus, and not on bulk modulus. It is named after A. E. H. Love, the English mathematician who discovered it. Syn: *Q wave*.

**low** A general term for such features as a structural basin, a syncline, a saddle, or a sag. Cf: *high*. Syn: *structural low*.

**low-angle fault** A fault dipping less than 45°. Cf: *high-angle fault*.

**low-energy environment** An aqueous sedimentary environment

characterized by a low *energy level* and by standing water or a general lack of wave or current action, thereby permitting very fine-grained sediment to settle and accumulate; e.g. a coastal lagoon or an alluvial swamp Cf: *high-energy environment*.

**lower** Pertaining to strata that are below those of later formations of the same subdivision of rocks. The adjective is applied to the name of a system, series, or stage to indicate position in the geologic column, and corresponds to *early* as applied to the name of the equivalent geologic-time unit; e.g. rocks of the Lower Jurassic System were formed during the Early Jurassic Period. The initial letter is capitalized to indicate a formal subdivision (e.g. "Lower Devonian") and is lowercased to indicate an informal subdivision (e.g. "lower Miocene"). Cf: *upper*; *middle*.

**Lower Carboniferous** In European usage, the approximate equivalent of the *Mississippian*. Cf: *Upper Carboniferous*.

**lower core** A term that includes the earth's *inner core* and the transitional zone of the *outer core*, i.e. the equivalent of the *F layer* and the *G layer*.

**lower mantle** That part of the *mantle* that lies below a depth of about 1000 km and has a density of 4.7 g/cm<sup>3</sup>, in which the seismic velocity increases slowly with depth. It is equivalent to the *D layer*.

**low-grade** Said of an ore with a

relatively low ore-mineral content. Syn: *lean*. Cf: *high-grade*.

**lowland** 1. A general term for extensive plains not far above sea level. 2. The low and relatively level ground of a region, in contrast with adjacent higher country, e.g. a vale between cuestas. 3. A bottom along a stream. --Ant: *upland*.

**low oblique** An oblique aerial photograph that does not include the horizon. Cf: *high oblique*.

**low quartz** *alpha quartz*.

**low-rank graywacke** A graywacke in which feldspar is almost absent. It is characteristic of miogeosynclinal deposits. Cf: *high-rank graywacke*.

**low-rank metamorphism** Metamorphism accomplished under conditions of low to moderate temperature and pressure. Cf: *high-rank metamorphism*, *metamorphic grade*.

**low tide** The tide at its lowest; the minimum level reached during a tide cycle.

**low-velocity-layer correction** *weathering correction*.

**low-velocity zone** 1. *weathered layer*. 2. The zone in the upper mantle, variously defined as from 60 to 250 km in depth, in which velocities are about 6% lower than in the outermost mantle. It is probably caused by the near-melting-point temperature of the material. Syn: *B layer*. 3. A region inside the core boundary below a depth of 2900 km which produces a *shadow zone* at the earth's surface.

**low-volatile bituminous coal** Bituminous coal, characteristically agglomerating, that contains 15-22% volatile matter, analyzed on a dry, mineral-matter-free basis. It has over 15,000 BTU/lb (on a moist, mineral-matter-free basis). Cf: *high-volatile bituminous coal*, *medium-volatile bituminous coal*.

**LPG liquefied petroleum gas**

**L-tectonite** (*L-tec'-ton-ite*) A tectonite whose fabric is dominated by the presence of lineations, such as deformed conglomerate in which the pebbles are strongly elongate. Cf: *S-tectonite*; *B-tectonite*.

**Lüder's lines** Planar deformation features, wider than ordinary shear fractures, inclined along planes of high shear stress, on which plastic or cataclastic deformation is concentrated.

**luminescence** (*lu-mi-nes'-cence*)

The emission of light by a substance that has received energy or electromagnetic radiation of a different wavelength from an external stimulus; also, the light so produced. It occurs at temperatures lower than those required for incandescence. See also: *phosphorescence*; *fluorescence*.

**lumping** In taxonomy, the practice of ignoring minor differences in the recognition or definition of species and genera. A taxonomist known for his frequent lumping of taxa is called a "lumper". Cf: *splitting*.

**lunar** 1. Pertaining to or occurring on the moon, as "lunar dust". 2.

resembling the surface of the moon, as a "lunar landscape" produced by strip mining

**lunar crater** A roughly circular depression in the surface of the moon, ranging in diameter up to hundreds of kilometers and relatively shallow. Lunar craters may have formed by meteor impact, volcanic activity, or subsidence. *See crater*

**lunar geology** A science that applies geologic principles and techniques to the study of the moon esp. its composition and the origin of its surface features. *See also selenology*

**lunarite** (lu'-na-rī-tē) A general term for light-toned brightly reflecting surface rocks of the lunar highlands or *terrae*

**lunar plays** A relatively small level area on the moon's surface, as much as a few kilometers long, occupying a low place in the ejecta blankets surrounding lunar craters such as Tycho and Copernicus. It is believed to be either a *fallback* deposit or a small lava flow

**lunar regolith** A thin, gray layer on the surface of the moon, perhaps several meters deep, consisting of partly cemented or loosely compacted fragmental material ranging in size from microscopic particles to blocks more than a meter in diameter. It is believed to be formed by repeated meteoritic and secondary fragment impact

over a long period of time. *Syn. lunar soil.*

**lunar soil** *lunar regolith.*

**lunate bar** (lu'-nate) A crescentic-shaped bar commonly found off the entrance to a harbor

**luster** (lus'-ter) The reflection of light from the surface of a mineral, described by its quality and intensity, the appearance of a mineral in reflected light. Terms such as metallic or resinous refer to general appearance, terms such as bright or dull refer to intensity

**luster mottling** 1 The shimmering appearance of a broken surface of a sandstone cemented with calcite, produced by the brilliant reflection of light from the cleavage faces of calcite crystals a centimeter or more in diameter incorporating colonies of detrital sand grains. 2 The macroscopic appearance of *poikilitic* rocks

**lutaceous** (lu-ta'-ceous) Said of a sedimentary rock formed from mud, pertaining to a lutite. Also said of the texture of such a rock. *Cf. argillaceous.*

**lutite** (lu' tite) A general name for rocks composed of material that was once mud, e.g. shale, mudstone, calcilutite. *Etymol.* Latin *lutum*, "mud." *Cf. pelite.* *See also rudite, arenite.*

**L wave** *surface wave*

**lysocline** (ly'-so-cline) The level or ocean depth at which the rate of solution of calcium carbonate just exceeds its combined rate of deposition and precipitation

# M

**maar** A low-relief, broad volcanic crater formed by multiple shallow explosive eruptions. It may contain a lake. Type occurrence is in the Eifel area of Germany.

**maceral** (mac'-er-al) One of the organic constituents that comprise the coal mass, all petrologic units seen in polished or thin sections of coal. Macerals are to coal as minerals are to inorganic rock. Cf. *phyteral*.

**maceration** (mac'-er-a-tion) The process of disintegrating sedimentary rocks such as coal and shale in order to extract and concentrate acid-insoluble microfossils. It includes mainly chemical treatment by oxidants and alkalis that will remove extraneous mineral and organic constituent. Maceration is widely used in *palynology*.

**macro-** A prefix meaning "large" or "great". Cf. *micro-*. Syn. *mega-*.

**macro-axis** (mac'-ro-ax'-is) The longer lateral axis of an orthorhombic or triclinic crystal, it is usually the *b* axis. Cf. *brachy-axis*.

**macrocrystalline** (mac'-ro-crys'-tal-line) Said of the texture of a rock consisting of crystals that are distinctly visible to the unaided eye or with the use of a simple lens, also, said of a rock with such a texture. Syn. *eucrystalline*. Cf. *microcrystalline*, *mesocrystalline*.

**macroevolution** (mac'-ro-ev-o-lu'-

tion) 1 The evolution or origin of higher taxa, esp. orders or classes, as contrasted to *microevolution*.

2 Evolution occurring in large, complex stages, such as the development of one species from another. Cf. *microevolution*.

**macrofacies** (mac'-ro-fa'-cies) *ja-*

*cies tract*

**macrofossil** (mac'-ro-fos'-sil) A fossil large enough to be studied without the aid of a microscope. Cf. *microfossil*. Syn. *megafossil*.

**macropinacoid** (mac'-ro-pin'-a-coid) *front pinacoid*.

**macroscopic** (mac'-ro-scop'-ic) *megascopic*

**maculose** (mac'-u-lose) Spotted, esp. as applied to a group of contact-metamorphic rocks, the *spotted slates*, also, said of the feature itself.

**mafic** Said of an igneous rock composed chiefly of dark, ferromagnesian minerals, also, said of those minerals. It is the complement of *felsic*. Cf. *femic*, *salic*. Etyr. of a mnemonic term derived from *magnesium* + *ferric* + *ic*.

**magma** (mag'-ma) Naturally occurring molten rock material, generated within the earth and capable of intrusion and extrusion, from which igneous rocks have been derived through solidification and related processes. It may or may not contain suspended solids (such as crystals and rock fragments) and/or gas phases. Adj. *magmatic*.

**magma chamber** A reservoir of magma in the shallow part of the lithosphere (to a few km or tens of

km), from which volcanic materials are derived; the magma has ascended into the crust from an unknown source. Syn: *magma reservoir*.

**magmatic** (mag-mat'-ic) Of, pertaining to, or derived from magma. Syn: *orthotectic*.

**magmatic differentiation** The process of developing more than one type of igneous rock, in situ, from a common magma.

**magmatic ore deposit** An ore deposit formed by *magmatic segregation*, generally in mafic rocks and layered intrusions, as crystals of metallic oxides or from an immiscible sulfide liquid.

**magmatic segregation** Concentration of crystals of a particular mineral (or minerals) in certain parts of a magma during its cooling and crystallization. Economically valuable *magmatic ore deposits* are formed in this way. Syn: *segregation*.

**magmatic stoping** A process of magmatic emplacement or intrusion that involves detaching and engulfing pieces of the country rock. The engulfed material presumably sinks downward and/or is assimilated. See also: *piecemeal stoping*; *ring-fracture stoping*.

**magmatism** (mag'-ma-tism) 1. The development and movement of magma, and its solidification to igneous rock. 2. The theory that much granite has formed through crystallization from magma rather than through *granitization*. See: *magmatist*.

**magmatist** (mag'-ma-tist) A

proponent of the theory of *magmatism*.

**magnetofacies** (mag'-na-fa'-cies) A major, continuous belt of deposits, with similar lithologic and paleontologic characters, that extends obliquely across time planes or through several chronostratigraphic units. It represents a depositional environment that persisted with more or less shifting of geographic placement during time. Cf: *parafacies*. Approx. syn: *lithosome*. Etymol: Latin *magna*, "great", + *facies*.

**magnesia** (mag-ng'-sia) Magnesium oxide, MgO.

**magnesian limestone** (mag-ne'-sian) A limestone that contains appreciable magnesium, e.g. one having at least 90% calcite and no more than 10% dolomite. Cf: *high-calcium limestone*; *dolomitic limestone*.

**magnesite** (mag'-ne-site) A white to gray mineral,  $MgCO_3$ , generally found as earthy masses or irregular veins. It is used in making refractory magnesia.

**magnet** 1. Any body that orients itself in a definite direction when suspended in any magnetic field, such as that of the earth. 2. Any shaped mass of ferromagnetic material that has been permanently magnetized.

**magnetic bearing** (mag-net'-ic) A bearing measured clockwise from magnetic north at the point of observation.

**magnetic compass** An instrument having a freely pivoted magnetic needle that aligns with the earth's



magnetic field so that one end of the needle points to the magnetic north. Syn: *compass*.

**magnetic declination** The acute angle between the directions of the magnetic and geographic meridians.

**magnetic dip** *magnetic inclination*

**magnetic equator** The line on the surface of the earth where the magnetic needle remains horizontal, i.e. where the magnetic inclination is zero. Syn: *acclinic line*.

**magnetic field** 1. The region of influence of a magnetized body or an electric current. 2. *magnetic-field intensity*

**magnetic-field intensity** The force exerted by the magnetic field on a magnetic material at a point in space. Syn: *magnetic field*, *magnetic-field strength*

**magnetic-field strength** *magnetic-field intensity*.

**magnetic force** 1. The physical force experienced by a magnetic substance when placed in a *magnetic field* or between magnetized bodies and electric currents. 2. A nonrecommended syn. of *magnetic-field intensity*.

**magnetic inclination** The angle at which magnetic-field lines dip. Syn: *inclination*; *magnetic dip*.

**magnetic intensity** *magnetic-field intensity*.

**magnetic meridian** *magnetic north*.

**magnetic north** The uncorrected direction indicated by the north-seeking end of the needle of a magnetic compass; the northerly direction of the magnetic meridian at any given point. Cf: *true*

*north*. Syn: *magnetic meridian*.

**magnetic polarity reversal** *geomagnetic reversal*.

**magnetic pole** Either of two areas near opposite ends of a magnet where the magnetic intensity is greatest. If a magnet is permitted to rotate freely, one pole will point toward the earth's magnetic north pole; this is termed the positive or north-seeking pole. The opposite pole is the negative or south-seeking pole.

**magnetic prospecting** A technique of applied geophysics: a survey is made with a magnetometer, on the ground or in the air, which yields local variations, or anomalies, in magnetic-field intensity. These anomalies are interpreted as to the depth, size, shape, and magnetization of geologic features causing them.

**magnetic pyrites** *pyrrhotite*.

**magnetic reversal** *geomagnetic reversal*.

**magnetic storm** A world-wide disturbance of the earth's magnetic field, commonly with amplitude of 50 to 200 gammas. It generally lasts several days, and is thought to be caused by charged particles ejected by solar flares. Magnetic prospecting usually has to be suspended during such periods.

**magnetic susceptibility** The ratio of induced magnetization to the strength of the magnetic field causing the magnetization. Syn: *susceptibility*.

**magnetism** (mag'-net-izm) A class of physical phenomena associated with moving electricity, including

the mutual mechanical forces among magnets and electric currents.

**magnetite** (mag'-net-ite) A black, isometric, strongly magnetic, opaque mineral of the spinel group,  $(\text{Fe}, \text{Mg})\text{Fe}_2\text{O}_4$ . It often contains titanium oxide, and it constitutes an important ore of iron. Magnetite is a very common and widely distributed accessory mineral in rocks of all kinds. It also occurs as a *heavy mineral* in sands.

**magnetization** (mag'-ne-ti-za'-tion) The magnetic moment per unit volume. The magnetization of a rock is the sum of its two types: *induced magnetization* and *remanent magnetization*. Syn: *volume magnetization*.

**magnetometer** (mag-ne-tom'-e-ter) An instrument that measures the earth's magnetic field and its changes. In ground prospecting, it usually measures the vertical intensity; in airborne prospecting, the total intensity.

**magnetometry** Measurement of the earth's magnetic field.

**magnetosphere** (mag-ne'-to-sphere) The confines of the earth's magnetic field, modified by influence of the solar wind. On the sunlit side, the magnetosphere is approximately hemispherical, with a radius of about ten earth radii under quiet conditions; it may be compressed to about six earth radii by magnetic storms. Opposite the sunlit side, the magnetosphere extends in a "tail" of several hundred earth radii.

**magnetostriction** (mag-ne'-to-stric'-tion) Elastic strain or deformation accompanying magnetization.

**magnitude** (mag'-ni-tude) *earthquake magnitude*.

**malachite** (mal'-a-chite {mal'-a-kite}) A bright green mineral,  $\text{Cu}_2\text{CO}_3(\text{OH})_2$ . It is a minor ore of copper and a common secondary mineral, associated with azurite, in the oxidized zone of copper-sulfide deposits. It is used to make ornamental objects.

**malpais** (mal'-pa-is) A term used in the southwestern U.S. for a region of rough and barren lava flows. The connotation of the term varies according to the locality. Etymol: Spanish, *mal país*, "bad land".

**Malthusian principle** (Mal-thu'-si-an) The concept that all animals, including man, potentially outbreed the food supply; conversely, the food supply is the primary limiting factor on population. Thus, most populations, if allowed a free breeding range, maintain themselves at the point of starvation.

**mammal** Any vertebrate of the class Mammalia: warm-blooded, clothed in hair, bringing forth their young alive and nursing them. Range, Jurassic to present.

**mammillary** (mam'-mil-lar-y) Forming smoothly rounded masses resembling breasts or portions of spheres. Said of the shape of some mineral aggregates, as malachite or limonite.

**manganese nodule** (man'-ga-nese)

An irregular potato-shaped mass of manganese-rich material that occurs on the ocean floor. Where concentrated, these nodules have potential value owing to their content of manganese, cobalt, copper, and nickel.

**manganite** (man'-ga-nite) A gray to black orthorhombic mineral,  $MnO(OH)$ . It is an ore of manganese.

**mantle** ('man'tle) 1 The zone of the earth below the crust and above the core; it is divided into the *upper mantle* and the *lower mantle*, with a transition zone between. 2 *regolith mantle rock*. 3 That part of the body wall in a mollusk or brachiopod that lines the shell and bears the shell-secreting glands.

**mantle rock** *regolith*

**manto** (man'-t.) A flat-lying bedded deposit, either a sedimentary bed or a replacement stratabound orebody. Etymol. Spanish "vein, stratum."

**map** *n*. A representation on a plane surface, at an established scale, of the physical features (natural, artificial, or both) of a part or the whole of the earth's surface, or of any desired surface or subsurface area, by means of signs and symbols, with the means of orientation indicated. — *v*. To produce or prepare a map, or engage in a mapping operation.

**map projection** 1 A network formed by two intersecting systems of lines, representing parallels of latitude and meridians of longitude, that portray on a flat

surface the whole or any part of the curved surface of the earth. 2 Any system by which a map projection is made, the process of transferring the outline of the earth's surface features onto a plane. 3 The mathematical concept of such a system.

**map scale** The ratio of the distance between two points on a map and the actual distance between the corresponding points on the earth's surface. Scale may be expressed as a *representative fraction*, e.g. "1/24,000", a verbal statement, e.g. "1 inch = 1 mile", or a bar or line marked off in feet, miles, or kilometers. Syn. *scale*.

**marble** (mar'-ble) 1 A metamorphic rock consisting predominantly of fine- to coarse-grained recrystallized calcite and/or dolomite. 2 In commerce, any crystallized carbonate rock, including true marble and certain types of limestone (*orthomarl*), that will take a polish and can be used as architectural or ornamental stone. 3 *verd antique*.

**marcasite** (mar'-ca-site) A common pale yellow or gray orthorhombic mineral,  $FeS_2$ , dimorphous with pyrite. It is common as nodules and concretions in sedimentary rocks.

**mare** (ma're) One of the several dark, low-lying, level, relatively smooth, plains-like areas of considerable extent on the surface of the moon, having fewer large craters than the highlands, and composed of mafic or ultramafic volcanic rock. Etymol. Latin, "sea".

from Galileo's belief that they represented great seas of water.  
Pl: *maria*.

**mare basin** A large, approximately circular or elliptical topographic depression in the lunar surface, filled or partly filled with mare material.

**mare material** Dark, relatively smooth, heavily cratered igneous rock, chiefly of mafic or ultramafic composition, underlying the lunar maria.

**mare ridge** *wrinkle ridge*.

**marginal fissure** (*mar'-gin-al*) A fracture, bordering an igneous intrusion, that has become filled with magma.

**marginal sea** A semi-enclosed sea adjacent to a continent, floored by submerged continental mass.

**marginal trench** *trench*.

**maria** Plural of *mare*.

**marigram** (*mar'-i-gram*) A graphic record of the rise and fall of the tide.

**marine** (*ma-rine'*) Of, or belonging to, or caused by the sea.

**marine abrasion** 1. Erosion of a bedrock surface by the to-and-fro movements of an overlying layer of sand under the influence of waves. 2. Erosion of submarine canyons by downslope movement of sediments under the influence of gravity.

**marine-built terrace** A *wave-built terrace* produced by marine processes.

**marine cave** *sea cave*.

**marine-cut platform** A *wave-cut platform* produced by marine processes.

**marine-cut terrace** A syn. of *marine-cut platform*. The term is inconsistent because a terrace is usually regarded as a constructional feature.

**marine geology** *geological oceanography*.

**marine terrace** 1. A narrow coastal strip, formed of deposited material, sloping gently seaward. 2. A *wave-cut platform* that has been exposed by uplift along a seacoast or by lowering of sea level; an elevated marine-cut bench. 3. A wave-cut platform, that merges into a *wave built terrace*.

**marine transgression** *transgression*.  
**marker** 1. A rock unit or stratigraphic feature that is distinctive and easily recognized over long distances, esp. in the subsurface, e.g. a bed or beds readily identified on an electric log. Syn. *marker bed*, *marker horizon*. 2. A layer that accounts for a characteristic segment of a seismic-refraction time-distance curve and can be followed over reasonably extensive areas.

**marker bed** 1. A geologic formation serving as a *marker*. 2. *key bed*.

**marker horizon** A *marker* represented by a rock surface or stratigraphic level, such as a boundary based on electric or other mechanically recorded logs, that may serve to delineate lithostratigraphic units.

**marl** An old term loosely applied to a variety of materials, mostly unconsolidated earthy deposits consisting chiefly of an intimate

mixture of clay and calcium carbonate, usually including shell fragments and sometimes glauconite. It is formed under marine and esp. freshwater conditions. It has been used as a fertilizer for acid soils. Cf: *marlstone*.

**marlstone** 1. An indurated rock of about the same composition as *marl*, i.e. an earthy or impure argillaceous limestone. It has a blocky subconchoidal fracture, and is less fissile than shale. 2. A term originally applied to slightly magnesian calcareous mudstones or muddy limestones in the Green River Formation of the Uinta Basin Utah, but later applied to associated rocks with a variety of lithologic characters. Abandonment of the term as used in the Uinta Basin has been recommended.

**marsh** A saturated, poorly drained area, intermittently or permanently water-covered, having aquatic and grasslike vegetation, essentially without the formation of peat. Cf: *swamp*; *bog*. Adj: *paludal*.

**Marshall line** (Mar'-shall) *andesite* line

**marsh gas** *Methane* produced during the decay of vegetable substances in stagnant water

**marsupial** (mar-su'-pi-al) A member of an order of mammals characterized by lack of placenta and consequent birth of young at a very immature state, with later development taking place in a specialized pouch. Examples: kangaroo; opossum. Cf: *placen-*

*tal*.

**martite** (mar'-tite) Hematite occurring in iron-black octahedral crystals pseudomorphous after magnetite.

**mascon** (mas'-con) A large-scale high-density lunar mass concentration below a ringed mare. Etymol: *mass* + *concentration*.

**massif** (mas-sif') 1. A massive topographic and structural feature, especially in an orogenic belt, commonly formed of rocks more rigid than those of its surroundings. These rocks may be protruding bodies of basement rocks, consolidated during earlier orogenies, or younger plutonic bodies. Examples are the crystalline massifs of the Helvetic Alps, whose rocks were deformed mainly during the Hercynian orogeny, long before the Alpine orogeny. 2. A mountainous mass or a group of connected heights, whether isolated or forming a part of a larger mountain system.—Etymol: French

**massive** (mas'-sive) 1. Said of rocks of any origin that are more or less homogeneous in texture or fabric, displaying an absence of flow layering, foliation, cleavage, joints, fissility, or thin bedding. 2. In rock mechanics, said of a durable rock that is essentially isotropic and homogeneous and is free of fissures, bedding, and other planar discontinuities. 3. Said of a mineral that is physically isotropic. 4. Said of a mineral deposit, esp. of sulfides, characterized by a great concentration of ore in one

place, as opposed to a disseminated or veinlike deposit.

**massive sulfide deposit** Any mass of unusually abundant metallic sulfide minerals, e.g. a *kuroko deposit*.

**mass movement** Unit downslope movement of a portion of the land surface, as in creep, landslide, or slip

**mass spectrometer** An instrument for determining, usually by electrical means, molecular weights and relative abundances of isotopes within a compound.

**mass susceptibility** *Magnetic susceptibility* divided by density, the ratio of specific induced magnetization to the strength of the magnetic field. Syn: *specific susceptibility*.

**mass transport** 1. The movement of water, esp. its net transfer by wave action in the direction of wave travel 2. The carrying of material in a moving medium --- water, air, or ice Cf. *mass wasting*

**mass wasting** A general term for the downslope movement of soil and rock material under the direct influence of gravity. The debris removed is not carried within, on, or under another medium. Syn: *downwasting; mass movement*.

**master joint** (mas'-ter) A joint plane of greater-than-average extent.

**mastodon** (mas'-to-don) One of a group of extinct, elephantlike mammals widely distributed in the Northern Hemisphere in the Oligocene and Pleistocene. It dif-

fers from mammoths and other true elephants in that teeth are low-crowned, with closed roots

**matrix** (ma'-trix) 1. The *ground-mass* of an igneous rock. 2. The finer-grained material enclosing the larger grains in a sediment or sedimentary rock. 3. The rock or sediment in which a fossil is embedded 4. A gemstone cut from a mineral and the surrounding rock material, e.g. opal matrix. 5. A local term for the phosphate-bearing gravel in the land-pebble deposits of Florida

**matterhorn** A sharp, hornlike or pyramid-shaped mountain somewhat resembling the Matterhorn, a peak in the Pennine Alps.

**mature** (ma-ture') 1. Pertaining to the stage of *maturity* in the cycle of erosion 2. Said of a clastic sediment that has evolved from its parent rock by processes acting over a long period of time and with a high intensity; it is characterized by stable minerals and absence of weatherable materials Cf. *immature, submature*.

**mature soil** *zonal soil*.

**mature valley** The valley of a stream that has developed to the stage of *maturity*, i.e. a graded stream.

**maturity** (ma-tu'-ri-ty) 1. The second of the three principal stages of the cycle of erosion in the development of a landscape, intermediate between youth and old age. It includes the period of maximum topographic diversity, during which nearly all the gradation is accomplished. Syn: *topographic*

**maturity.** 2. The stage in the development of a stream at which it reaches its maximum efficiency, having attained a *profile of equilibrium* and a velocity just sufficient to carry the sediment delivered to it by tributaries. 3. A stage in the development of a shoreline that begins when a profile of equilibrium is attained and progresses to a smooth, regular shoreline devoid of bays and headlands. 4. The extent to which a clastic sediment approaches the end product to which it is driven by the processes that operate on it. See: *maturity index*.

**maturity index** A measure of the progress of a clastic sediment in the direction of chemical or mineralogic stability; e.g. a high ratio of alumina to soda, of quartz to feldspar, or of quartz + chert to feldspar + rock fragments, indicates a highly mature sediment.

**maximum** (max'-i-mum) 1. A geophysical anomaly with values greater than those in neighboring areas, e.g. a gravity maximum. 2. *point maximum*. 3. *glacial maximum*.

**M-discontinuity** (M'-dis-con-ti-nu'-i-ty) Syn. of *Mohorovičić discontinuity*. Also spelled: *M discontinuity*.

**mean** An average of a series of values; *arithmetic mean*. Cf: *mode*; *median*.

**meander** (me-an'-der) n. One of a series of sinuous curves or loops in the course of a mature stream, produced as the stream swings from side to side in flowing across

its floodplain or shifts its course laterally toward the convex side of an original curve.—v. 1. To wind or turn in a sinuous course. 2. To survey on or along a *meander line*.

**meander belt** The zone along a valley floor across which a meandering stream shifts its channel from time to time; specif. the area of the flood plain included between two lines drawn tangentially to the extreme limits of all fully developed meanders. It may be from 15 to 18 times the width of the stream.

**meander core** 1. The central hill enclosed by a meander. 2. *cutoff spur*.

**meander cutoff** The shortened channel resulting when a stream cuts through a *meander neck*.

**meandering stream** A mature stream winding freely on a broad flood plain.

**meander line** A surveyed line, usually irregular, but not a boundary line; sp. a traverse of the margin or bank of a permanent natural body of water.

**meander lobe** The more or less elevated, tongue-shaped area of land enclosed within a stream meander.

**meander neck** The narrow strip of land between adjacent loops of a meandering stream.

**meander scar** 1. *flood-plain meander scar*. 2. A crescentic cut in a bluff or valley wall, produced by sideward cutting of a meandering stream and indicating its former route.

**meander scroll** 1. One of a series of

arcuate ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank. 2. *ox-bow lake*.

**meander spur** An undercut projection of high land extending into the concave part of a meander.

**mean high water** The average height of all the high waters recorded at a given place over a 19-year period or a computed equivalent period. Abbrev: MHW.

**mean low water** The average height of all the low waters recorded at a given place over a 19-year or computed equivalent period. Abbrev: MLW.

**mean refractive index** 1. The median index of refraction for any crystalline substance, with variation due to zoning. 2. The median index of refraction in any microcrystalline substance for which specific index values related to crystal directions are not determinable.

**mean sea level** The average height of the surface of the sea for all stages of the tide over a 19-year period; sea level midway between mean high water and mean low water. It is adopted as a *datum plane*, i.e. *sea-level datum*, for the measurement of elevations and depths. Abbrev: MSL. Popular syn: *sea level*.

**mean stress** The algebraic average of the three *principal stresses*.

**measured reserves** (mea'-sured) *developed reserves*.

**mechanical analysis** (mē-chan'-i-

cal) Determination of the particle-size distribution of a soil, sediment, or rock by screening, sieving, or other means of mechanical separation. It is usually expressed in percentage by weight of particles within specific size limits.

**mechanical twinning deformation twinning**.

**mechanical weathering** The process of weathering by which frost action, salt-crystal growth, absorption of water, and other physical processes break down a rock to fragments, involving no chemical change. Cf: *chemical weathering*. Syn: *physical weathering*; *disintegration*.

**medial moraine** (me'-di-al) 1. An elongate moraine carried in or on the middle of a glacier and parallel to its sides, usually formed by the merging of lateral moraines below the junction of two coalescing valley glaciers. 2. A moraine formed by glacial abrasion of a rocky protuberance near the middle of a glacier, whose debris appears at the glacier surface in the ablation area. 3. The irregular ridge left behind in the middle of a glacial valley, when the glacier on which it was formed has disappeared.

**median** (me'-di-an) The value of the middle item in a set of data arranged in rank order. If the set of data has an even number of items, the median is the arithmetic mean of the middle two ranked items. Cf: *mean*; *mode*.

**median diameter** An expression of the average particle size of a sedi-



ment or rock, obtained graphically by locating the diameter associated with the midpoint of the particle-size distribution; the middlemost diameter that is larger than 50% of the diameters in the distribution and smaller than the other 50%.

**medical geology** (med'-i-cal) The application of geology to medical and health problems, involving such subjects as the occurrence of toxic elements in unusual quantities in parts of the earth's crust, the distribution of trace elements as related to nutrition, or the geographic patterns of disease. The medical syn. is "regional pathology". See also: *environmental geochemistry*.

**Medinan** (Me-di'-nan) Obsolete syn. of *Alexandrian*.

**mediterranean** (med'-i-ter-ra'-ne-an) n. *mesogeosyncline*.—adj. Said of a deep sea that is in or between continents and connects with the ocean by a narrow opening.

**Mediterranean suite** A major group of igneous rocks, characterized by high potassium content. This suite was so named because of the predominance of potassium-rich lavas around the Mediterranean Sea; specif. those of Vesuvius and Stromboli. Cf: *Atlantic suite*; *Pacific suite*.

**medium bands** (me'-di-um) In banded coal, vitrain bands from 2.0 to 5.0 mm thick. Cf: *thin bands*; *thick bands*; *very thick bands*.

**medium-grained** 1. Said of an igne-

ous rock, and of its texture, in which the individual crystals have an average diameter in the range of 1-5 mm (0.04-0.2 in.). 2. Said of a sedimentary rock, and of its texture, in which the individual particles have an average diameter in the range of 1/16 to 2 mm (62-2000 microns, or sand size).—The term is used in a relative sense to describe rocks that are neither *coarse-grained* nor *fine-grained*.

**medium-volatile bituminous coal** (me'-di-um-vol'-a-tile) Bituminous coal, characteristically agglomerating, that contains 23-31% volatile matter, analyzed on a dry, mineral-matter-free basis. Cf: *high-volatile bituminous coal*; *low-volatile bituminous coal*.

**meerschaum** (meer'-schaum) Massive *sepiolite*. Etymol: German *Meerschaum*, "sea froth".

**mega-** A prefix signifying "large" or "great". Syn: *macro-*.

**megabreccia** (meg-a-brec'-cia) A rock produced by collapse owing to sol. solution, containing blocks that are randomly oriented and invariably inclined at angles from 6° to 25° and that range from a meter to more than 100 m in horizontal dimension. 2. A breccia containing individual blocks as much as 400 m long, developed downslope from large thrusts by gravitational sliding. It is partly tectonic and partly sedimentary in origin, containing blocks that are shattered but little rotated.—Cf: *chaos*.

**megacyclothem** (meg-a-cy'-clo-them) A combination of related

*cyclothems*, or a cycle of cyclothems, such as in the Pennsylvanian of Kansas. Also, a cyclothem on a large scale, comprising minor cyclothems.

**megafauna** (meg'-a-fau-na) Animals, living or fossil, that are large enough to be seen and studied with the unaided eye.

**megafloora** (meg'-a-flō-ra) Plants, living or fossil, that are large enough to be seen and studied with the unaided eye.

**megafossil** (meg'-a-fos-sil) Fossil that are large enough to be seen with the unaided eye.

**megaripple** (meg'-a-rip-ple) A large sand wave or ripplelike feature having a wavelength greater than 1 m or a ripple height greater than 10 cm, formed in a subaqueous environment.

**megascopic** (meg'-a-scop'-ic) Said of an object or phenomenon, or of its characteristics, that can be observed with the unaided eye or with a hand lens. Syn. *macroscopic*.

**megashear** (meg'-a-shear) A strike-slip fault with a horizontal displacement that exceeds significantly the thickness of the crust.

**megatectonics** (meg'-a-tee-ton'-ics) The tectonics of the very large structural features of the earth, or of the whole earth. Cf. *new global tectonics*.

**Meinzer unit** (Mein'-zer) *permeability coefficient*.

**meizoseismal** (mei-zō-seis'-mal) Pertaining to the maximum destructive force of an earthquake.

**melange** (me-lange') A mappable

body of rock that includes fragments and blocks of all sizes, both exotic and native, embedded in a fragmented and generally sheared matrix. It may be an *olistostrome* of sedimentary origin, or a tectonic melange. Etymol. French, "mixture." Cf. *chaos*.

**melanic** (me-lan'-ic) *melanocratic*.  
**melanocratic** (mel'-a'-no-crat'-ic) Dark-colored applied to igneous rocks containing more than 60% mafic minerals. Cf. *leucocratic*, *mesocratic*. Syn. *melanic*.

**melilite** (mel'-i-lite) A group of minerals of the general formula  $(\text{Na,Ca})_2(\text{Mg,Al})_3(\text{Si,Al})_3\text{O}_7$ . It consists of an isomorphous solid-solution series, and may contain some iron. It occurs as a component of certain recent basic volcanic rocks.

**mellorite** (mel'-lor-ite) *fireclay mineral*.

**melt n** In petrology, a liquid fused rock.

**member** A lithostratigraphic unit of subordinate rank comprising some specially developed part of a *formation*. It may be formally defined and named, informally named, or unnamed. It is not necessarily mappable, and a named member may extend from one formation into another. Abbrev. *mbr*. Cf. *lentil*, *ungue*.

**mendip** (men'-dip) A hill on a coastal plain which at one time was an offshore island.

**Meramecian** (Mer-a-mec'-i-an) Lower part of the Upper Mississippian of North America.

**Mercalli scale** (Mer-cal'-li) An ar-

bitrary scale of *earthquake intensity*, ranging from I (detectable only instrumentally) to XII (causing almost total destruction). It is named after Giuseppe Mercalli (d. 1914) the Italian geologist who devised it in 1902. Its adaptation to North American conditions is known as the *modified Mercalli scale*.

**Mercator projection** (Mer-ca' tor)

A map projection in which the equator is represented by a straight line true to scale, the meridians by parallel straight lines perpendicular to the equator and equally spaced according to their distance apart at the equator, and the parallels by straight lines perpendicular to the meridians and the same length as the equator. There is great distortion of distances, areas, and shapes in the polar regions. Because any line of constant direction on the sphere is truly represented on the projection by a straight line, the Mercator projection is of great value in navigation and is used for hydrographic charts and to plot trajectories of earth satellites in oblique orbits.

**mercury** (mer'-cu-ry) A heavy, silver-white to tin-white hexagonal mineral, the native metallic element Hg. It is the only metal that is liquid at ordinary temperatures. Native mercury is found as minute fluid globules disseminated through cinnabar (the principal ore of mercury) or deposited from the waters of certain hot springs, but it is unimportant as a source

of the metal. It usually contains small amounts of silver. Mercury combines with most metals to form alloys or amalgams. It is highly toxic if breathed or ingested. Syn *quicksilver*.

**mercury barometer** A type of *barometer* that measures barometric change by its effect on the mercury or other liquid in a U-shaped glass tube closed at one end. Cf *aneroid barometer*.

**meridian** (me-ri'di-an) 1. An imaginary great circle on the surface of the earth passing through the poles and perpendicular to the equator, connecting all points of equal *longitude*. 2. A north-south line of constant longitude. 3. Any one of a series of lines, corresponding to meridians, drawn on a globe, map, or chart at intervals due north and south and numbered according to the degrees of longitude east or west from the prime meridian. Cf *parallel*.  
**mercerystalline** (mer-crys'-tal-line) *hypocrystalline*.

**merohedral** (me-ro-he'di-al) Said of crystal classes in a system, the general form of which has only one half, one fourth, or one eighth the number of equivalent faces of the corresponding form in the *holohedral* class of the same system. Cf *tetartohedral*. Syn *merosymmetric*. See also *hemihedral*.

**merostome** (mer'-e-stom) Any aquatic *arthropod* belonging to the class Merostomata, characterized by the presence of one pair of preoral appendages with three or four joints. Cf *curvpterid*.

**merosymmetric** (mer'-o-sym-met'-ric) *merohedral*.

**mesa** (me'-sa [may'-sa]) A tableland; a flat-topped mountain or plateau bounded on at least one side by a steep cliff. Cf: *butte*. Etymol: Spanish, "table".

**meseta** (me-se'-ta) 1. A small *mesa*. 2. An extensive plateau, often with an uneven or eroded surface, forming the central physical feature of a region; e.g. the high, dissected tableland of the interior of Spain.—Etymol: Spanish, "tableland"

**mesh** 1. One of the openings in a sieve or screen. The value of the mesh is usually given as the number of openings per linear inch. 2. The unit component of patterned ground (excepting steps and stripes), e.g. circle, polygon, or intermediate form.

**mesh texture** A rock texture that is *reticulate*.

**meso-** A prefix meaning "middle"

**mesocratic** (mes-o-crat'-ic) Composed of almost equal amounts of light and dark constituents; applied to igneous rocks intermediate in color between *leucocratic* and *melanocratic*, and containing 30% to about 65% of mafic minerals.

**mesocrystalline** (mes-o-crys'-tal-line) Said of the texture of a rock consisting of crystals intermediate in size between those of a *microcrystalline* and a *macrocrystalline* rock; also, said of a rock with such a texture.

**mesogene** (mes'-o-gene) Said of a mineral deposit or enrichment of

mingled *hypogene* and *supergene* solutions; also, said of such solutions and environment.

**mesogeosyncline** (mes'-o-ge'-o-syn'-cline) A geosyncline between two continents and receiving clastics from both of them. Syn: *mediterranean*.

**mesonorm** (mes'-o-norm) Theoretical calculation of minerals in metamorphic rocks of the *mesozone* as indicated by chemical analyses. Cf: *catanorm*; *epinorm*.

**mesopelagic** (mes'-o-pe-lag'-ic) Pertaining to the *pelagic* environment of the ocean between 100 and 500 fathoms. Cf: *epipelagic*.

**mesosiderite** (mes-o-sid'-er-ite) A *stony-iron meteorite* in which the silicates are mainly pyroxene and calcic plagioclase. Mesosiderites often appear to be breccias made up of fragments of widely different chemical and mineralogical composition, in a nickel-iron matrix. Olivine is sometimes present. Syn: *grahamite*.

**mesothermal** (mes'-o-ther'-mal) 1. Said of a hydrothermal mineral deposit formed at considerable depth and in the temperature range of 200°-300°C; also, said of that environment. Cf: *hypothermal*; *epithermal*. 2. Said of an organism that prefers moderate temperatures. 3. Pertaining to a climate characterized by moderate temperature.

**Mesozoic** (Mes-o-zo'-ic) An era of geologic time, from the end of the Paleozoic to the beginning of the Cenozoic, or from about 225 to

about 65 million years ago; also, the rocks formed during that era. It includes the Triassic, Jurassic, and Cretaceous periods. See also: *age of reptiles*.

**mesozone** (mes'-o-zone) The intermediate *depth zone* of metamorphism, characterized by temperatures of 300°-500°C and moderate hydrostatic pressure and shearing stress Cf: *katazone*; *epizone*.

**meta-anthracite** (met-a-an'-thra-cite) Coal having a fixed-carbon content of 98% or more; the highest rank of anthracite.

**metabentonite** (met-a-ben'-ton-ite) Metamorphosed, altered, or somewhat indurated bentonite, characterized by clay minerals (esp. illite) that no longer have the property of absorbing or adsorbing large quantities of water. The term has been applied to certain Ordovician clays of the Appalachian region and upper Mississippi River valley. See also: *potassium bentonite*.

**metacryst** (met'-a-cryst) A large crystal developed in a metamorphic rock by recrystallization, such as garnet or staurolite in mica schist. Syn: *porphyroblast*.

**metal** (met'-al) 1. Any of a class of chemical elements, as iron, gold, aluminum, etc., generally characterized by ductility, malleability, luster, and conductivity of heat and electricity. 2. In the older geologic literature, a now obsolete term for any hard rock. It survives in the term *road metal*.

**metallimnion** (met-a-lim'-ni-on) The horizontal layer of a thermal-

ly stratified lake in which the temperature decreases rapidly with depth. The metallimnion lies between the *epilimnion* and the *hypolimnion*, and includes the thermocline.

**metallic** (me-tal'-lic) 1. Pertaining to a metal. 2. Said of a type of luster that is characteristic of metals. Cf: *nonmetallic*; *submetallic luster*.

**metalliferous** (me-tal'-lif'-er-ous) Metal-bearing, specif., pertaining to a mineral deposit from which a metal or metals can be extracted by metallurgical processes.

**metallogenetic province** (me-tal'-lo-ge-net'-ic) *metallogenic province*.

**metallogenic epoch** (me-tal'-lo-gen'-ic) A unit of geologic time favorable for the deposition of ores, or characterized by a particular assemblage of mineral deposits. Several metallogenic epochs may be represented within a single area, or *metallogenic province*.

**metallogenic province** An area characterized by a particular assemblage of mineral deposits, or by one or more characteristic types of mineralization. A metallogenic province may have had more than one episode of mineralization, or *metallogenic epoch*. Syn: *metallogenetic province*.

**metallogeny** (me-tal'-log'-o-ny) The study of the genesis of mineral deposits, with emphasis on their relationship in space and time to regional petrographic and tectonic features of the earth's crust.

Adj. *metallogenic*

**metallurgy** (met'-al-lur-gy in U.S.; met-al-lur-gy in Britain) The science and art of separating metals from their ores and preparing them for use, as by smelting and refining.

**metaluminous** (met-a lu'-mi-nous)

In the Shand classification of igneous rocks, a division embracing those rocks in which the molecular proportion of aluminum oxide is greater than that of sodium and potassium oxides combined but generally less than that of sodium, potassium, and calcium oxides combined. Cf. *peralkaline*, *peraluminous*, *subaluminous*.

**metamict** (met'-a-mict) Said of a mineral containing radioactive elements in which various degrees of lattice disruption have taken place as a result of radiation damage while its original external morphology has been retained. Examples occur in zircon, thorite and several other minerals.

**metamorphic** (met-a mor'-phic) adj. Pertaining to the process of metamorphism or to its results.

n. A *metamorphic rock*.

**metamorphic differentiation** A collective term for the various processes by which minerals or mineral assemblages are locally segregated from an initially uniform parent rock during metamorphism, e.g. garnet porphyroblasts in fine-grained mica schist.

**metamorphic facies** A set of metamorphic rocks characterized by particular mineral associations,

indicating origin under restricted temperature-pressure conditions. Syn. *mineral facies*.

**metamorphic grade** The intensity of metamorphism, measured by the degree of difference between the parent rock and the metamorphic rock. It indicates in a general way the P-T environment or facies in which the metamorphism took place. For example, conversion of shale to slate or phyllite would be low-grade metamorphism, whereas its continued alteration to a garnet-sillimanite schist would be high-grade metamorphism. Syn: *metamorphic rank*.

**metamorphic rank** *metamorphic grade*.

**metamorphic rock** Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the earth's crust.

**metamorphism** (met-a-mor'-phism) The mineralogical, chemical, and structural adjustment of solid rocks to physical and chemical conditions imposed at depth below the surface zones of weathering and cementation, which differ from the conditions under which the rocks originated. See also. *contact metamorphism*; *dynamic metamorphism*; *thermal metamorphism*.

**metaquartzite** (met-a-quartz'-ite) A quartzite formed by meta-

morphic recrystallization, as distinguished from an *orthoquartzite*, whose crystalline nature is of diagenetic origin.

**metasediment** (met-a-sed'-i-ment)

A sediment or sedimentary rock that shows evidence of having been subjected to metamorphism.

**metasomatic** (met'-a-so-mat'-ic)

Pertaining to the process of metasomatism and to its results. The term is especially used in connection with the origin of ore deposits.

**metasomatism** (met-a-som'-a-

tism) The process of practically simultaneous capillary solution and deposition by which a new mineral may grow in the body of an old mineral or mineral aggregate. The presence of interstitial, chemically active pore liquids or gases contained within the rock body or introduced from external sources are essential for the process, which often, though not necessarily, occurs at constant volume with little disturbance of textural or structural features. Cf: *pyrometasomatism*. Syn: *replacement*.

**metasomatite** (met-a-som'-a-tite)

A rock that has undergone metasomatism.

**metastable** (met-a-sta'-ble) 1. Said of a phase that is stable with respect to small disturbances but that is capable of reaction with evolution of energy if sufficiently disturbed. 2. Said of a phase that exists in the temperature range in which another phase of lower vapor pressure is stable.

**metastasis** (me-tas'-ta-sis) *metastasy*.

**metastasy** (me-tas'-ta-sy) Lateral adjustments of the earth's crust, as opposed to vertical movements (isostasy). Syn: *metastasis*.

**metavolcanics** (met'-a-vol-can'-ics)

An informal term for volcanic rocks that show evidence of having been subjected to metamorphism.

**Metazoa** (Met-a-zo'-a) The large group of multicellular animals in which the cells are arranged in two layers in the embryonic gastrula stage.

**meteor** (me'-te-or) 1. The visible streak of light resulting from the entry into the atmosphere of a solid particle from space. 2. Any relatively small fragment of solid material associated with a meteor and made luminous as a result of friction during its passage through the earth's atmosphere; a *meteoroid*. Syn: *shooting star*.

**meteor crater** *meteorite crater*.

**meteoric** (me-te-or'-ic) 1. Of or relating to meteors. 2. Pertaining to or derived from the earth's atmosphere, e.g. *meteoric water*.

**meteoric water** Water that occurs in or is derived from the atmosphere.

**meteorite** (me'-te-or-ite) Any solid object from interplanetary space that has fallen to the earth's surface without being vaporized by frictional heating during its passage through the atmosphere; a stony or metallic object large enough to reach the ground. Most meteorites are believed to be frag-

ments of asteroids and to consist of primitive solid matter similar to that from which the earth was originally formed. Adj: *meteoritic*.

**meteorite crater** An *impact crater* formed by the falling of a large meteorite onto a surface; e.g. Barringer Crater (Meteor Crater) in Coconino County, Ariz., and Chubb Crater in Quebec, Canada. Syn: *meteor crater*.

**meteorology** (me'-te-o-rol'-o-gy) The science dealing with the atmosphere and its phenomena, especially as they relate to weather forecasting.

**methane** (meth'-ane) A colorless odorless inflammable gas, the simplest paraffin hydrocarbon, formula  $\text{CH}_4$ . It is the principal constituent of natural gas and is also found associated with crude oil. See also: *marsh gas*; *fire damp*.

**methylene iodide** (meth'-yl-ene) A liquid compound,  $\text{CH}_2\text{I}_2$ , that is used as a *heavy liquid*; its specific gravity is 3.33.

**mgd** Millions of gallons per day. The abbreviation is commonly used to express rate of flow.

**MHW** *mean high water*.

**miarolitic** (mi'-a-ro-lit'-ic) A term applied to small irregular cavities in igneous rocks, esp. "granites", into which crystals of the rock-forming minerals protrude; pertaining to such cavities or a rock containing them.

**mica** 1. A group of monoclinic minerals of the general formula  $(\text{K}, \text{Na}, \text{Ca}) (\text{Mg}, \text{Fe}, \text{Li}, \text{Al})_{2-3} (\text{Al}, \text{Si})_4 \text{O}_{10} (\text{OH}, \text{F})_2$ . It consists of

complex *phyllosilicates* with perfect basal cleavage, which split into thin elastic laminae and range from colorless to black. Micas are prominent rock-forming constituents of igneous and metamorphic rocks. Sheet muscovite is used in electric insulators, and ground mica in paint and as a dusting agent. Syn: *isinglass*. 2. Any mineral of the mica group, esp. muscovite, biotite, lepidolite, phlogopite, and sericite.

**mica book** A crystal of mica, usually large and irregular. It is so named because of the resemblance of its cleavage plates to the leaves of a book.

**micaceous** (mi-ca'-ceous) 1. Consisting of, containing, or pertaining to mica; e.g. a "micaceous sediment". 2. Resembling mica; e.g. a "micaceous mineral" capable of being easily split into thin sheets, or a "micaceous luster".

**micrite** (mic'-rite) 1. A descriptive term for the semiopaque crystalline matrix of limestones, consisting of chemically precipitated carbonate mud with crystals less than 4 microns in diameter, and interpreted as a lithified ooze. The term is now commonly used in a descriptive sense without genetic implication. Micrite is finer-textured than *sparite*. 2. A limestone with less than 1% allochems and consisting dominantly of micrite matrix; e.g. *lithographic limestone*.

**micro-** A prefix meaning "small". When modifying a rock name, it signifies fine-grained hypabyssal, as in "microgranite". Cf: *macro-*.



**microcline** (mi'-cro-cline) A white, gray, brick-red, or green mineral of the alkali feldspar group:  $KAlSi_3O_8$ . It is the fully ordered, triclinic modification of potassium feldspar and is dimorphous with orthoclase, being stable at lower temperatures; it usually contains sodium in minor amounts. Microcline is a common rock-forming mineral of granitic rocks and pegmatites, and is often secondary after orthoclase. It is generally characterized by cross-hatch twinning.

**microcoquina** (mi'-cro-co-qui'-na [mi'-cro-ko-kee'-na]) 1. A detrital limestone composed wholly or chiefly of weakly cemented shell detritus of sand size (2 mm in diameter) or less. 2. A variety of chalk.—Cf: *coquina*.

**microcrystalline** (mi'-cro-crys'-tal-line) Said of the texture of a rock consisting of crystals that are visible only under the microscope; also, said of a rock with such a texture. Cf: *cryptocrystalline*. See also: *macrocrystalline*; *mesocrystalline*.

**microevolution** (mi'-cro-ev-o-lu'-tion) 1. The evolution or origin of species, as contrasted to that of higher taxa. 2. Evolution that occurs within a continuous population but does not result in the development of genetic discontinuities; the changes, brought about by selective accumulation of minute variations, are thought to be chiefly responsible for evolutionary differentiation.—Cf: *macroevolution*, from which it

probably differs only in degree.

**microfabric** (mi'-cro-fab'-ric) The fabric of a rock as seen under the microscope.

**microfacies** (mi'-cro-fa'-cies) Those distinctive aspects of a sedimentary rock that are visible and identifiable only under the microscope (low-power magnification).

**microfauna** (mi'-cro-fau'-na) Living or fossil animals too small to be seen with the unaided eye. Cf: *microflora*; *megafauna*.

**microflora** (mi'-cro-flo'-ra) Living or fossil plants too small to be seen with the unaided eye. The term is commonly misapplied to the *microfossil* remains of higher plants. Cf: *microfauna*; *megaflo-*

**microfossil** (mi'-cro-fos'-sil) A fossil too small to be studied without the aid of a microscope, e.g. an invertebrate such as a *foraminifer* or an *ostracode*. It may be the remains of a microscopic organism or a part of a larger organism. Cf: *macrofossil*; *nannofossil*.

**microgranular** (mi'-cro-gran'-u-lar) 1. Said of the texture of a microcrystalline xenomorphic igneous rock; also, said of a rock with such a texture. 2. Said of the texture of a carbonate sedimentary rock wherein the particles are mostly 10 to 60 microns in diameter and are well sorted, and finer clay-sized matrix is absent; also, said of a rock with such a texture. 3. Said of a foraminiferal wall made of minute calcite crystals.

**microlite** (mi'-cro-lite) 1. A microscopic crystal that polarizes light

and has some determinable optical properties. 2. An isometric mineral of the pyrochlore group that occurs in pegmatites and constitutes an ore of tantalum.

**microlitic** (mi-cro-lit'-ic) Said of the texture of a porphyritic igneous rock in which the groundmass is composed of an aggregate of differently oriented or parallel microlites in glassy or cryptocrystalline interstitial material.

**Microlog** (Mi'-cro-log) Trade name for a *well log* designed to measure the resistivity of a small volume of rock next to the borehole. Response is dominated by the presence of drilling mud caked on the walls of the hole, which causes separation between otherwise virtually coincident curves and thus indicates porous zones.

**micrometeorite** (mi-cro-me'-te-or-ite) A meteorite particle with a diameter generally less than a millimeter, so small that it undergoes atmospheric entry without vaporizing or becoming intensely heated and hence without disintegration.

**micropaleontology** (mi'-cro-pa'-le-on-tol'-o-gy) The study of fossils too small to be observed without the aid of a microscope; the study of microfossils.

**micropertite** (mi-cro-perth'-ite) A fine-grained intergrowth of potassic and sodic feldspar in which the lamellae (5-100 microns wide) are visible only with the aid of the microscope. Cf. *cryptopertite*.

**microphotograph** (mi-cro-pho'-to-

graph) A less-preferred syn. of *photomicrograph*.

**microphyritic** (mi-cro-phyr'-ic) Said of the texture of a porphyritic igneous rock in which the phenocrysts are of microscopic size, i.e. their longest dimension does not exceed 0.2 mm; also, said of a rock having such texture. Syn: *microporphyritic*.

**microplankton** (mi-cro-plank'-ton) Plankton ranging in size from 60 microns to 1 millimeter, including most phytoplankton.

**micropoikilitic** (mi'-cro-poi-ki-lit'-ic) Said of the *poikilitic* texture of an igneous rock that can be distinguished only with the aid of a microscope; also, said of a rock having such texture.

**microporphyritic** (mi'-cro-por-phy-rit'-ic) *microphyritic*.

**microscopic** (mi-cro-scop'-ic) 1. Said of an object or phenomenon or of its characteristics that cannot be observed without the aid of a microscope. 2. Of or pertaining to a microscope.

**microseism** (mi'-cro-seism) A collective term for small motions in the earth that are unrelated to an earthquake and that have a period of 1.0-9.0 sec. They are caused by a variety of natural and artificial agents, e.g. wind or strong ocean waves.

**microstructure** (mi'-cro-struc-ture) 1. The internal structure and character of plant and animal tissues, esp. skeletal tissues, as revealed by the microscope. 2. Structural features of rocks that can be discerned only with the aid

of the microscope.

**microstylolite** (mi-cro-sty'-lo-lite)

A *stylolite* in which the relief along the surface is less than a millimeter, such as one indicating differential solution between two mineral grains.

**microtectonics** (mi'-cro-tec-ton'-ics) A syn. of *structural petrology*.

**Mid-Atlantic ridge** That part of the *mid-oceanic ridge* that extends through the North and South Atlantic Oceans.

**middle** Pertaining to a segment of time intermediate between *early* and *late*, or to rocks or strata intermediate between *lower* and *upper*. The adjective is applied to the name of a system, series, or stage, or to the corresponding era, period, or epoch; e.g. rocks of a Middle Jurassic batholith were formed in Middle Jurassic time. The initial letter of the term is capitalized to indicate a formal subdivision (e.g. "Middle Devonian") and is lowercased to indicate an informal subdivision ("middle Miocene").

**mid-oceanic ridge** (mid'-o-co-an'-ic) A continuous median mountain range extending through the North and South Atlantic Oceans, the Indian Ocean, and the South Pacific Ocean. It is a broad, fractured swell, seismically active, with a central rift valley and rugged topography; it is 1-3 km in elevation, about 1500 km in width, and over 84,000 km in length. According to the hypothesis of sea-floor spreading, the mid-oceanic ridge is the source of

new crustal material. See also: *rift valley*; *sea-floor spreading*. Syn: *mid-ocean rise*; *mid-ocean ridge*. **mid-ocean ridge** *mid-oceanic ridge*. **mid-ocean rift** *rift valley*.

**mid-ocean rise** *mid-oceanic ridge*.

**magma** (mig'-ma) Mobile, or potentially mobile, mixture of solid rock material and magma, the magma having been injected into or melted out of the rock material. Etymol: Greek, "mixture".

**migmatite** (mig'-ma-tite) A rock composed of igneous or igneous-appearing and/or metamorphic materials, which are generally distinguishable megascopically.

**migration** (mi-gra'-tion) 1. The movement of oil and gas from their source beds through permeable formations into reservoir rocks. 2. The process by which events on a reflection seismogram are mapped in an approximation of their true spatial positions. 3. The movement of the crest of a divide away from an actively eroding stream on a steep slope toward a weaker stream on a gentler slope. 4. The slow downstream shifting of a system of meanders, accompanied by enlargement of the curves and widening of the meander belt. 5. The movement of a dune by the continued transfer of sand from its windward to its leeward side. 6. A broad term for the movements of plants and animals from one place to another over long periods of time.

**military geology** (mil'-i-tar-y) Those branches of the earth

sciences, especially geomorphology, soil science, and climatology, that are applied to such military concerns as terrain analysis, water supply, cross-country movement, location of construction materials, and the building of roads and airfields.

**Miller indices** A set of three or four symbols (letters or integers) used to define the orientation of a crystal face or internal crystal plane. The indices are determined by expressing, in terms of lattice constants, the reciprocals of the intercepts of the face or plane on the 3 crystallographic axes, and reducing (clearing fractions) if necessary to the lowest integers retaining the same ratio. When the exact intercepts are unknown, the general symbol (*hkl*) is used for the indices, where *h*, *k*, and *l* are respectively the reciprocals of rational but undefined intercepts along the *a*, *b*, and *c* crystallographic axes. In the hexagonal system, the Miller indices are (*hkl*).

**millidarcy** (mil'-li-dar-cy) The customary unit of measurement of fluid permeability, equivalent to 0.001 *darcy*. Abbrev: md.

**milligal** (mil'-li-gal) A unit of acceleration used with gravity measurements;  $10^{-3}$  gal =  $10^{-5}$  m/sec<sup>2</sup>. Abbrev: mgal.

**millig ore** An ore that needs preliminary treatment before it is of a sufficiently high grade to be acceptable for shipment or market.

**Mima mound** (My'-ma) A term

used in the NW U.S. for one of numerous low, circular or oval domes composed of unstratified gravelly silt and soil material, built on glacial outwash on a *hog-wallow* landscape; the basal diameter ranges from 3 m to more than 30 m, and the height from 30 cm to about 2 m. The mounds are probably built by pocket gophers. Named after the Mima Prairie in western Washington State. Cf. *pimple mound*.

**mimetic** (mi-met'-ic) 1. Said of an organism that exhibits a similarity with its surroundings, as a means of concealment or protection. 2. Said of a twinned or malformed crystal that "appears to have a higher grade of symmetry than it actually has." 3. Said of a *tectonite* whose fabric reflects and is influenced by pre-existing anisotropic structure; also, said of the fabric itself.

**Mindel** (Min'-del) The second of four classical glaciations in Europe, above Günz, below Riss.

**Mindel-Riss** The term applied in the Alps to the second classical interglacial stage of the Pleistocene Epoch, after the Mindel glacial stage and before the Riss.

**mine** *n.* 1. An underground excavation for the extraction of mineral deposits, in contrast to surficial excavations such as quarries. The term is also applied to various types of open-pit workings. 2. The area or property of a mineral deposit that is being excavated; a mining claim.—*v.* To excavate for and extract mineral deposits or

building stone

**mineral** (min'-er-al) 1 A naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties. Those who include the requirement of crystalline form in the definition would consider an amorphous compound such as opal to be a *mineraloid*. 2 Any naturally formed inorganic material, i.e. a member of the mineral kingdom as opposed to the plant and animal kingdoms.

**mineral deposit** A mass of naturally occurring mineral material, e.g. metal ores or nonmetallic minerals, usually of economic value, without regard to mode of origin. Accumulations of coal and petroleum may or may not be included, usage should be defined in context.

**mineral facies** 1 *metamorphic facies*. 2 Rocks of any origin whose constituents have been formed within the limits of a pressure-temperature range characterized by the stability of certain index minerals.

**mineral filler** A finely pulverized inert mineral or rock that is included in a manufactured product, e.g. paper, rubber, and plastics, to impart certain useful properties, such as hardness, smoothness, or strength. Common mineral fillers include asbestos, kaolin, and talc.

**mineralization** (min'-er-al-i-za-tion) 1 The process by which a

valuable mineral or minerals are introduced into a rock, resulting in a potential or actual ore deposit. It is a general term and includes various types, e.g. fissure filling, impregnation, replacement. 2 A process of fossilization in which the organic components are replaced by inorganic material.

**mineralize** (min'-er-al-ize) To convert to a mineral substance; to impregnate with mineral material. The term is applied to the process of ore formation and also to the process of fossilization.

**mineralizer** (min'-er-al-iz-er) 1 A gas or fluid that dissolves, removes by fractionation, transports and precipitates ore minerals. A mineralizer is typically aqueous, with various hyperfugible gases ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{H}_2\text{S}$ ,  $\text{HF}$ ), simple ions ( $\text{H}^+$ ,  $\text{HS}^-$ ,  $\text{Cl}^-$ ,  $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ), complex ions (esp. chloride complexes), and dissolved base and precious metals. 2 A gas that is dissolved in a magma and that aids in the concentration, transport and precipitation of certain minerals and in the development of certain textures as it is released from the magma by decreasing temperature and/or pressure. Cf. *fugitive constituent*, *volatile component*.

**mineralogical phase rule** (min'-er-al-og'-i-cal) *Goldschmidt's phase rule*.

**mineralogy** (min-er-al'-o-gy) The study of minerals: formation, occurrence, properties, composition, and classification. Adj. *min-*

*erological*

**mineraloid** (min'-er-al-oid) A naturally occurring, usually inorganic substance that is not considered to be a *mineral* because it is amorphous and thus lacks characteristic crystal form. e.g. opal  
**mineral resources** *resources*

**mineral spring** A spring whose water contains enough mineral matter to give it a definite taste, in comparison to ordinary drinking water, esp. if the taste is unpleasant or if the water is regarded as having therapeutic value

**mineral water** Water that contains naturally or artificially supplied mineral salts or gases (e.g. carbon dioxide)

**mineral wool** A generic term for felted or matted fibers manufactured by blowing or spinning threads of molten rock, slag, or glass. The material is used for thermal insulation. Syn. *rock wool*

**minimum** (min-i-mum) 1. A geophysical anomaly showing values smaller than those in neighboring areas, e.g. a gravity minimum. 2. *glacial minimum*

**minimum-time path** The path between two points along which the time of seismic wave travel is less than on neighboring paths. Syn. *least time path*

**mining** The process of extracting metallic or nonmetallic mineral deposits from the earth. The term may also include preliminary treatment, e.g. cleaning or sizing. Cf. *development exploration*

**mining claim** A *claim* on mineral

lands

**mining engineering** The planning and design of mines, taking into account economic, technical, and geologic factors; also supervision of the extraction, and sometimes the preliminary refinement, of the raw material. Cf. *mining*, *mining geology*

**mining geology** The study of the geologic aspects of mineral deposits, with particular regard to problems associated with mining  
**minor elements** *trace elements*

**Miocene** (Mi'-o-cene) An epoch of the early Tertiary period, after the Oligocene and before the Pliocene; also, the corresponding worldwide series of rocks. It is considered to be a period when the Tertiary is designated as an era

**miogeosyncline** (mi'-o-ge'-o-syn'-cline) A geosyncline in which volcanism is not associated with sedimentation; the nonvolcanic aspect of an orthogeosyncline located near the craton. Cf. *eugeosyncline*

**mirabilite** (mi-rab-i-lite) A white or yellow monoclinic mineral,  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ . It occurs as a residue from saline lakes, playas, and springs, and is a commercial source of sodium sulfate. Syn. *Glauber's salt*

**miscible** (mis-ci-ble) Said of two or more phases that when brought together have the ability to mix and form one phase. Cf. *immiscible*

**mispickel** (mis-pick-el) *arsenopyrite*

**Mississippian** (Mis-sis sip'-pi an)

A period of the Paleozoic era (after the Devonian and before the Pennsylvanian), thought to have covered the span of time between 347 and 320 million years ago, also the corresponding system of rocks. It is named after the Mississippi River valley in which there are good exposures of rocks of this age. It is the approximate equivalent of the *Lower Carboniferous* of European usage.

**Mississippi Valley-type deposit** A strata-bound deposit of lead and/or zinc minerals in carbonate rocks together with associated fluorite and barite. These deposits characteristically have relatively simple mineralogy, occur as veins and replacement bodies, are at moderate to shallow depths, show little postore deformation, are marginal to sedimentary basins, and are without an obvious source of the mineralization. Examples: Wisconsin Illinois lead deposits; Kentucky Illinois fluor spar deposits; Appalachian zinc and barite deposits.

**Missourian** (Mis sou'-ri an) Lower part of the Upper Pennsylvanian of North America.

**mixed-base crude** A crude oil in which both paraffinic and naphthenic hydrocarbons are present in approximately equal proportion. Cf. *paraffin-base crude* as *phalt base crude*.

**mixed crystal solid solution.**

**mixed layer** The layer of ocean water above the thermocline. It is mixed by wind action. It is

equivalent to the *epilimnion* in a lake.

**mixed-layer mineral** A mineral whose structure consists of alternating layers of clay minerals and/or mica minerals, e.g. chlorite, made up of alternating biotite and brucite sheets.

**MLW** *mean low water*

**mobile belt** (mo-bile) A long, relatively narrow crustal region of tectonic activity, measured in scores of miles. The term *geosyncline* is applied to its phase of sedimentation and subsidence. See also *orogenic belt*, *orogenic cycle*.

**mobilization** (mo-bi-li-za'-tion) 1 Any process that renders a solid rock sufficiently plastic to permit it to flow or to permit geochemical migration of the mobile components. Cf. *rheomorphism*. 2 Any process that redistributes and concentrates the valuable constituents of a rock into an actual or potential ore deposit.

**mode** 1 The actual mineral composition of a rock, usually expressed in weight or volume percent. Adj. *modal*. Cf. *norm*. 2 The value or group of values that occurs with the greatest frequency in a set of data, the most typical observation. Cf. *mean*, *median*.

**model** A working hypothesis or precise simulation, by means of description, statistical data, or analogy, of a phenomenon or process that cannot be observed directly or that is difficult to observe directly. Models may be

derived by various methods, e.g. by computer, from stereoscopic photographs, or by scaled experiments.

**modified Mercalli scale** An earthquake *intensity scale*, having twelve divisions ranging from I (not felt by people) to XII (damage nearly total). It is a revision of the *Mercalli scale*. Cf: *Rossi-Forel scale*.

**modulus of compression** (mod'-u-lus) *compressibility*.

**modulus of elasticity** The ratio of stress to its corresponding strain under given conditions of load, for materials that deform elastically, according to Hooke's law. See also: *Young's modulus*; *modulus of rigidity*; *bulk modulus*. Syn: *modulus of volume elasticity*.

**modulus of incompressibility** *bulk modulus*.

**modulus of rigidity** A *modulus of elasticity* in shear. Symbol:  $\mu$  or  $G$ . Syn: *shear modulus*; *rigidity modulus*.

**modulus of volume elasticity** *modulus of elasticity*.

**mofette** (mo-fette') The exhalation of carbon dioxide in an area of late-stage volcanic activity; also, the small opening from which the gas is emitted. It is a type of *fumarole*. Examples are in Yellowstone National Park in the U.S. Etymol: French, "noxious gas"

**Moho** Abbreviation for Mohorovičić discontinuity.

**mohole** A proposed deep borehole to penetrate into the earth's mantle below the Mohorovičić discon-

tinuity.

**Mohorovičić discontinuity** (Mo'-ho-ro-vi'-čić) The boundary surface that separates the earth's crust from the subjacent mantle. It marks the level at which *P*-wave velocities change abruptly from 6.7-7.2 km/sec (in the lower crust) to 7.6-8.6 km/sec or average 8.1 km/sec (at the top of the upper mantle); its depth ranges from about 5-10 km beneath the ocean floor to about 35 km below the continents, although it may reach 60 km or more under some mountain ranges. It is variously estimated to be between 0.2 and 3 km thick. It is named in honor of its discoverer, Andrija Mohorovičić (1857-1936), Croatian seismologist. Syn: *Moho*, *M-discontinuity*.

**Mohs scale** A standard of ten minerals by which the hardness of a mineral may be rated. The scale includes, from softest to hardest and numbered one to ten, talc, gypsum, calcite, fluorite, apatite, orthoclase, quartz, topaz, corundum, and diamond.

**moisture content** 1. In coal, both the surface or free moisture that can be removed by natural drying, and the inherent moisture that is structurally contained in the substance. 2. The amount of moisture in a given soil mass, expressed as weight of water divided by weight of oven-dried soil, multiplied by 100 to give a percentage. See also: *water content*.

**molasse** (mo-lasse' [mo-las']) 1. A ~~mainly~~ marine, partly continental



or deltaic sedimentary facies consisting of a thick sequence of soft ungraded fossiliferous conglomerates, sandstones, shales, and marls, characterized by primary sedimentary structures and sometimes by coal and carbonate deposits. It is more clastic and less rhythmic than the preceding *flysch* facies. 2. An extensive postorogenic sedimentary formation representing the totality of the molasse facies resulting from the wearing down of elevated mountain ranges during and immediately after the main paroxysmal phase of an orogeny, and deposited considerably in front of the preceding *flysch*; specif. the Molasse strata mainly of Miocene and partly of Oligocene age, deposited on the Swiss Plain and Alpine foreland of southern Germany after the rising of the Alps.—Etymol. French *molasse*, "soft".

**mold** 1. An impression made in the surrounding earth or rock material by the exterior or interior of a fossil shell or other organic structure. See also: *external mold*; *internal mold*. Cf: *cast*. 2. *natural mold*. 3. A flute, groove, or other mark made on a sedimentary surface; the filling of such a depression produces a *cast*. Unfortunately, some authors reverse this usage, and others regard "mold" and "cast" as synonymous. 4. An old term for a soft, friable soil rich in humus, e.g. leaf mold.

**molding sand** A mixture of sand and refractory clay, used in

foundries for molds to receive molten metal.

**mole fraction** The number of moles of a given component in a phase, divided by the total number of moles of all components in the phase. Mole fractions are useful in defining the composition of a phase.

**Mollisol** (Mol'-li-sol) An order of soils that characteristically form under grass in climates that have a moderate to severe seasonal moisture deficit. They are dark-colored soils with a relatively high cation-exchange capacity dominated by calcium. Many are very productive agricultural soils.

**mollusk** (mol'-lusk) A solitary invertebrate belonging to the phylum Mollusca, characterized by a nonsegmented body that is bilaterally symmetrical and by a radially or biradially symmetrical mantle and shell. Among the classes included in the mollusks are the gastropods, pelecypods, and cephalopods. Adj: *molluscan*.

**Mollweide projection** (Moll'-wei-de) An equal-area map projection on which the entire surface of the earth is enclosed within an ellipse whose major axis (the equator, representing 360° of longitude) is twice the length of the minor axis (the central meridian, representing 180° of latitude). All parallels are represented by straight lines at right angles to the central meridian and more widely spaced at the equator than at the poles, and all meridians are represented

by equally spaced elliptical arcs with the exception of the central meridian (a straight line) and the meridian 90° from the center (a full circle, representing the hemisphere centered at the origin of the projection). There is excessive angular distortion at the margins of the map

**molybdate** (mo-lyb'-date) A mineral compound characterized by the radical  $\text{MoO}_4$ , in which the hexavalent molybdenum ion and the four oxygens form a flattened square rather than a tetrahedron. Tungsten and molybdenum may substitute for each other. An example of a molybdate is wulfenite,  $\text{PbMoO}_4$ . Cf. *tungstate*.

**molybdenite** (mo-lyb'-de-nite) A lead-gray hexagonal mineral  $\text{MoS}_2$ . It is the principal ore of molybdenum. Molybdenite generally occurs in foliated masses or scales, and is found in pegmatite dikes and quartz veins or disseminated in porphyry; it resembles graphite in appearance and to the touch, but has a bluer color.

**monadnock** (mo-nad'-nock) A hill or mountain rising conspicuously above the general level of a peneplain in a temperate climate, representing an isolated remnant in a region that has been largely beveled to its base level. Type locality. Mount Monadnock in New Hampshire. Cf. *catoclin*; *unaka*; *inselberg*.

**monazite** (mon'-a-zite) A yellow or brown monoclinic mineral,  $(\text{Ce}, \text{La}, \text{Nd}, \text{Th}) (\text{PO}_4, \text{SiO}_4)$ . It is a rare-earth phosphate with appre-

ciable substitution of thorium for rare earths and silicon for phosphorus; thorium-free monazite is rare. It is widely disseminated as an accessory mineral in granites, gneisses, and pegmatites, and it is often concentrated in detrital sands. Monazite is a principal ore of the rare earths and the main source of thorium.

**monoclinical scarp** A scarp resulting from a steep downward flexure between an upland block and a tectonic basin.

**monoclinical shifting** The downdip migration of a divide, and of a stream channel, resulting from the tendency of streams in a region of inclined strata to flow along the strike of less resistant strata, and for differential erosion to proceed more rapidly along the steeper slope of a cuesta or monocliminal ridge. Syn. *homoclinical shifting*. Cf. *migration*.

**monocline** (mon'-o-cline) A local steepening in an otherwise uniform gentle dip. Cf. *homocline*. Adj. *monoclinical*.

**monoclinic system** (mon-o-clin'-ic) One of the six crystal systems, characterized by either a single twofold axis of symmetry, a single plane of symmetry, or a combination of the two. Crystals belonging to this system are referred to three unequal crystallographic axes, two of which intersect obliquely and the third perpendicular to the plane formed by the other two.

**monogenetic** (mon'-o-ge-net'-ic) 1. Resulting from one process of for-

mation or derived from one source, or originating or developing at one place and time, e.g. said of a volcano built up by a single eruption. 2. Consisting of one element or type of material or having a homogeneous composition, e.g. said of a gravel composed of a single type of rock. Cf. *polygenetic*.

**monogeosyncline** (mon' o-ge-o-syn' cline) A single geosynclinal trough along a continental margin and accreting sediments from a hinterland on its oceanic side. Cf. *polygeosyncline*.

**monometric** (mon' o-met'ric) 1. Said of a lake with only one yearly *or return*. Tropical lakes overflow in the winter and polar lakes in the summer. 2. Said of a clastic sedimentary rock composed of a single mineral species. Cf. *oligometric polymetric*.

**monomineralic** (mon' o-min' eral' ic) Said of a rock composed wholly or almost wholly of a single mineral, esp. said of an igneous rock (such as anorthosite or dunite) consisting of one essential mineral. The amounts of other minerals tolerated under the definition vary with different authors. Cf. *polymineralic*.

**Monongahelan** (Mo' non -ga -he -lan) Upper Pennsylvanian of eastern North America.

**monophyletic** (mon' o-phy-let' ic) Evolving from a single ancestral stock. Cf. *polyphyletic*.

**monothem** (mon' o-them) A non-cyclic chronostratigraphic unit of genetically related strata.

**monotropy** (mo' not' ro-py) The relationship between two different forms of the same substance, e.g. pyrite and marcasite, that have no definite transition point since only one of the forms, i.e. pyrite, is stable and in which the change from the unstable to the stable form is reversible. Cf. *enantiotropy*.

**monotypic** (mon' o-type' ic) Said of a taxon, but includes only one taxon of that taxonomic rank, e.g. a genus with only one originally included species.

**mons** A prefix placed to contain on Mars. Most are of volcanic origin. Etymon: Latin *mons* = mountain. **montmorillonite** (mont' mo-ri-lon' ite) 1. A fibrous silicate clay mineral of the smectite group  $\text{Na}_{0.33}\text{Al}^{+1}(\text{Mg})_2\text{Si}_4\text{O}_{10}(\text{OH})_2 \cdot \text{H}_2\text{O}$ . It represents a high aluminous end member that has some slight replacement of  $\text{Al}^{+3}$  by  $\text{Mg}^{+2}$  and no substantial replacement of  $\text{Si}^{+4}$  by  $\text{Al}^{+3}$ . Cf. *beidellite*. 2. A term formerly used for the group of minerals to which the mineral montmorillonite belongs. Confusion is avoided by using *smectite* for the group name.

**monzonite** (mon' zo-nite) A group of plutonic rock intermediate in composition between *syenite* and *diorite*, containing approximately equal amounts of alkali feldspar and plagioclase, little or no quartz, and commonly augite as the main mafic mineral also, any rock in that group the intrusive equivalent of *latite*. Syn. *syenodiorite*.

*orite*.

**moonstone** A semitransparent to translucent alkali feldspar (adularia) or cryptoperthite that exhibits a bluish to milky-white pearly or opaline luster, an opalescent variety of orthoclase. Flawless moonstones are used as gemstones and as one of the birthstones for June. Cf. *sunstone*.

**morainal lake** A glacial lake occupying a depression resulting from irregular deposition of drift in an end moraine or ground moraine of a continental glacier.

**moraine** (mu-raine') 1 A mound or ridge of unstratified glacial drift, chiefly till, deposited by direct action of glacier ice. 2 Solidified volcanic debris carried on the surface of a lava flow.

**moraine kame** A kame that forms one of a group having the characteristics of a terminal moraine. See also *kame moraine*.

**morphogenesis** (mor-pho-gen'-e-sis) The origin and early development of landforms or a landscape. **morphogenetic region** (mor'-pho-gen-et'-ic) A climatic zone in which the predominant geomorphic processes produce distinctive landscape characteristics that contrast with those of other regions developed under different climatic conditions.

**morphogeny** (mor-phog'-e-ny) The interpretative morphology of a region; specif. *geomorphogeny*.

**morphologic species** A species based solely on characteristics of form and structure.

**morphologic unit** 1 A rock-strati-

graphic unit identified by its topographic features, e.g. an alluvial fan. Syn: *morphostratigraphic unit*. 2 A surface, either depositional or erosional, that is recognized by its topographic character.

**morphology** (mor-phol'-o-gy) 1 The shape of the earth's surface, *geomorphology*. 2 The study of the form and structure of animals and plants or their fossil remains, esp. of the relations and development of organs apart from their functions, also, the features included in the form and structure of an organism or any of its parts. 3 The study of the distributional patterns of horizons in a soil profile, and of the soil's properties. 4 The study of the dimensions, form, and structure of meteorites.

**morphometry** (mor-phom'-e-ty) 1 The measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimensions of its landforms. 2 The measurement of the form characteristics of lakes and their basins, also, the branch of limnology dealing with such measurements.

**morphostratigraphic unit** (mor'-pho-strat-i-graph'-ic) *morphologic unit*.

**Morrowan** (Mor'-row-an), Lower Pennsylvanian of North America. **mortar structure** (mor'-tar) A structure, presumably *cataclastic*, in granites and gneisses in which small crushed grains of quartz and feldspar occupy the interstices between larger individuals.

resembling stones set in mortar.  
**morvan** (mor'-van) 1. The intersection of two peneplains, as where an exhumed, tilted peneplain is cut across obliquely by a younger surface at a more nearly horizontal attitude. 2. A region that exhibits such a relationship.

**mosaic** (mo-sa'-ic) 1. *desert pavement*. 2. A petrologic texture in which mineral grains are approximately equant. 3. An assemblage of aerial photographs or space images that have been matched to form a continuous representation of a part of the earth's surface. 4. A pattern formed on the interior of certain brachiopod valves.

**mosaic breccia** A breccia in which the fragments have been largely but not wholly disjointed and displaced. Some fragments match along adjacent surfaces.

**mosaic texture** 1. A granoblastic texture in a dynamically metamorphosed rock in which the individual grains meet with straight or slightly curved, but not interlocking or sutured boundaries. 2. A texture in crystalline sedimentary rock characterized by more or less regular grain-boundary contacts.

**moss agate** A general term for translucent chalcedony containing inclusions of any color arranged in dendritic patterns resembling trees, ferns, moss, and similar vegetation; specif. an agate containing brown, black, or green mosslike markings due to visible inclusions of oxides of manganese and iron.

**moss animal bryozoan**.

**mother liquor** The residual solution, often impure or complex, that remains after the substances readily and regularly crystallizing have been removed.

**mother lode** 1. A main mineralized unit that may not be economically valuable in itself but to which workable veins are related, e.g. the Mother Lode of California. 2. An ore deposit from which a placer is derived.

**mottled limestone** Limestone with narrow branching fucoildike cylindrical masses of dolomite, often with a central tube or hole; it may be organic or inorganic in origin.

**mountain** (mou-lin' [moo-lanh']) A roughly cylindrical, nearly vertical hole or shaft in the ice of a glacier, scoured out by swirling meltwater as it pours down from the surface. Etymol: French, "mill", so called because of the loud roaring noise made by the falling water. Syn *glacial mill*; *pothole*, *glacier well*. See also: *glant's kettle*.

**mound** 1. A low rounded natural hill, generally of earth; a knoll. 2. A small man-made hill, composed either of debris accumulated during successive occupations of the site or of earth heaped up to mark a burial site. 3. An organic structure built by fossil colonial organisms, such as crinoids.

**mount** 1. An abbreviated form of the term *mountain*, esp. used preceding a proper name and usually referring to a particular sum-

mit within a group of elevations, e.g. Mount Marcy in the Adirondack Mountains. Abbrev. *mt*. 2. An eminence rising abruptly above the surrounding land surface, such as Mount Vesuvius. 3. *seamount*.

**mountain** (moun'-tain) 1. Any part of the earth's crust higher than a *hill*, sufficiently elevated above the surrounding land surface to be considered worthy of a distinctive name, and characterized by a restricted summit area. It can occur as an isolated eminence, or in a group forming a chain or range, and it may form by earth movements, erosion, or volcanic action. Generally, a mountain is considered to project at least 300 m (1000 ft) above the surrounding land. When the term is used following a proper name, it usually signifies a group of elevations, such as a range (e.g. the Adirondack Mountains) or a system (e.g. the Rocky Mountains). Abbrev. *mt*, *mnt*. Syn. *mount*. 2. A region characterized by mountains, term usually used in the plural.

**mountain chain** A complex, connected series of several more or less parallel *mountain ranges* and *mountain systems* grouped together without regard to similarity of form, structure, and origin, but having a general longitudinal arrangement or well-defined trend, e.g. the Mediterranean mountain chain of southern Europe. See also: *cordillera*. **mountain cork** 1. A white or gray variety of *asbestos* consisting of

thick interlaced fibers and resembling cork in texture and lightness (it floats on water). Syn: *mountain leather*. 2. A fibrous clay mineral such as *sepiolite* or *palygorskite*. **mountain glacier** *alpine glacier*.

**mountain leather** *mountain cork*.

**mountain pediment** 1. A plain of combined erosion and transportation at the foot of a desert mountain range, similar in form to an alluvial plain, and appearing at a distance to be a broad triangular mass (resembling a pediment or gable of a low-pitched roof) above which the mountain projects. 2. A pediment occurring within a mountain mass as a relatively high-altitude surface truncating a mountain structure.

**mountain range** A single, large mass consisting of a succession of mountains or narrowly spaced mountain ridges, with or without peaks, closely related in position, direction, formation, and age, a component part of a *mountain system* or of a *mountain chain*.

**mountain system** A group of *mountain ranges* exhibiting certain unifying features, such as similarity in form, structure, and alignment, and presumably originating from the same general causes; esp. a series of ranges belonging to an *orogenic belt*. Cf: *mountain chain*.

**moveout** The difference in arrival times of a reflection event on adjacent traces of a seismic record, esp. resulting from the dip of the reflecting interface. Cf: *normal moveout*.

**MSL** *mean sea level*

**muck** *n.* 1. Dark decomposed organic matter, intermixed with a high percentage of silt. 2. In mining, a syn. of waste rock.—*v.* To remove waste rock.

**micro** A short, sharp terminal point or spiny tip of an animal part or plant part

**mucronate** (mu'-cro-nate) Terminated by a distinct and obvious mucro.

**mud** 1 *drilling mud* 2 A sticky fine-grained marine sediment, usually described by color, e.g. red mud 3 A mixture of water with silt or clay-sized earth material, ranging from semi-fluid to soft and plastic 4 The mixed material of a *mudflow*

**mud crack** 1 An irregular fracture in a crudely polygonal pattern, formed by the shrinkage of clay, silt, or mud, generally in the course of drying under surface conditions. Also referred to as a *shrinkage crack* or *desiccation crack*. 2 A cast of a mud crack.—Also spelled *mudcrack*.

**mud engineer** A specialist who studies and prescribes the materials, chemicals, and proprietary additives to make up and maintain the properties of the *drilling mud* used in rotary drilling

**mud flat** A relatively level area of fine silt along a shore (as in a sheltered estuary) or around an island, alternately covered and uncovered by the tide, or covered by shallow water; a muddy tidal flat barren of vegetation.

**mudflow** A general term for a

mass-movement landform and process characterized by a flowing mass of fine-grained earth material with a high degree of fluidity. The water content may range up to 60%. See also: *earth-flow*, *debris flow*, *lahar*. Also spelled: *mud flow*.

**mudlump** A diapiric sedimentary structure that forms a small short-lived island, some 4000 square meters in area, near the mouth of a major distributary of the Mississippi River, it consists of a broad mound or swelling of silt or thick plastic clay that stands 2 to 4 m above sea level. It is created by the loading of rapidly deposited delta-front sands upon lighter-weight prodelta clays causing the clays to be intruded or thrust upward into and through the overlying sandbar deposits. Also spelled, *mud lump*.

**mud polygon** A *nonsorted polygon* whose center is bare of vegetation but whose outlining reticulate fissures contain peat and plants.

**mud pot** A type of hot spring containing boiling mud, usually sulfurous and often multicolored, as in a *paint pot*. Mud pots are commonly associated with geysers and other hot springs in volcanic areas, esp. Yellowstone National Park, Wyo. Syn. *sulfur-mud pool*.  
**mud pump** the reciprocating pump used to impel *drilling mud* through the essentially closed circulating system used in rotary drilling. Syn. *slush pump*.

**mud rock** A syn. of *mudstone*.

Also spelled: *mudrock*.

**mudstone** 1. An indurated mud having the texture and composition of shale, but lacking its fissility; a blocky fine-grained sedimentary rock in which the proportions of clay and silt are approximately equal; a nonfissile mud shale. See also: *claystone*; *siltstone*. 2. A general term that includes clay, silt, claystone, siltstone, shale, and argillite, and that should be used only when the amounts of clay and silt are not known or specified or cannot be precisely identified, or when it is desirable to characterize the whole family of finer-grained sedimentary rocks (as distinguished from sandstones and limestones). Syn: *mud rock*. 3. A mud-supported carbonate sedimentary rock containing less than 10% grains (particles with diameters greater than 20 microns); e.g. a calcilitite. Cf: *wackestone*; *packstone*; *grainstone*.

**mud volcano** An accumulation, usually conical, of mud and rock ejected by volcanic gases; also, a similar accumulation formed by escaping petroliferous gases.

**mullion structure** (mul'-lion) 1. The larger grooves on a fault surface, parallel to the direction of displacement. 2. *rodding structure*.

**mullite** (mull'-ite) A rare orthorhombic mineral:  $Al_6Si_2O_{13}$ . Synthetic mullite is a valuable refractory material. Syn: *porcelainite*.

**multi-** A prefix from the Latin, meaning "much" or "many".

**multicycle** (mul'-ti-cy-cle) adj. Said of a landscape or landform produced during more than one cycle of erosion, and bearing the traces of the former condition(s); e.g. a coast with a series of elevated sea cliffs separated from each other in stairlike fashion by narrow wave-cut benches, each cliff representing a separate shoreline cycle.

**multiglotation** (mul'-ti-glə'-tion) Repeated freezing and thawing.

**multipartite map** (mul-ti-par'-tī-e) A *vertical-variability map* that shows the degree of distribution of one lithologic type within certain parts (such as the top, middle, and bottom thirds) of a given stratigraphic unit.

**multiple intrusion** Any type of igneous intrusion that has been produced by several injections separated by periods of crystallization. Chemical composition of the various injections is approximately the same. Cf: *composite intrusion*.

**multiple reflection** A seismic wave that has been reflected more than once. Syn: *secondary reflection*.

**multiple working hypotheses** The name given by Chamberlin in 1897 to a method of "mental procedure" applicable to geologic studies, in which several rational and tenable explanations of a phenomenon are developed, coordinated, and evaluated simultaneously in an impartial manner.

**multiplex** (mul'-ti-plex) n. A stereoscopic plotting instrument used in preparing topographic



maps from aerial photographs.—

v. To transmit several channels of seismic information over a single channel without interference.

**muscovite** (mus'-co-vite) A mineral of the mica group:  $KAl_2(AlSi_3)O_{10}(OH)_2$ . It is colorless to pale brown, and is a common mineral in gneisses and schists, in granites and pegmatites, and in many sedimentary rocks, esp. sandstones. See also: *sericite*. Syn: *white mica*.

**mushroom ice** An ice pedestal with a round and expanded top.

**musical sand** (mu'-si-cal) A *sounding sand* that emits a definite musical note or tone when stirred, trodden on, or otherwise disturbed; esp. *whistling sand*.

**muskeg** (mus'-keg) A bog in wet, poorly drained boreal regions, often areas of permafrost. Tamarack and black spruce are commonly associated with muskeg areas.

**mutant** (mu'-tant) The offspring bearing a *mutation*.

**mutation** (mu-ta'-tion) A spontaneously occurring, fundamental change in heredity, which results in the development of new individuals that are genetically unlike their parents and therefore can be acted upon by natural selection to effect desirable changes and eventually to establish new species. Mutations are now thought to be chemical changes in the DNA of a chromosome; some are visible, but most are not; many are deleterious. Mutations

are the raw material of evolution.

See also: *mutant*.

**mutualism** (mu'-tu-al-iam) A relationship between two organisms in which both are benefited. Cf: *commensalism*; *symbiosis*.

**mylonite** (my'-lo-nite) A compact, chertlike rock with a streaky or banded structure, produced by the extreme granulation and shearing of rocks that have been pulverized and rolled during overthrusting or intense dynamic metamorphism. Mylonite may also be described as a microbreccia with flow texture.

**mylonitization** (my'-lo-nit-i-za'-tion) Deformation of a rock by extreme microbrecciation, due to mechanical forces applied in a definite direction, without noteworthy chemical reconstitution of granulated minerals. Also spelled: *mylonization*.

**myriapod** (myr'-i-a-pod) Any terrestrial arthropod belonging to the superclass Myriapoda, which includes centipedes and millipedes. They are rarely preserved as fossils but are known from the Upper Silurian to the present.

**myrmekite** (myr'-me-kite) An intergrowth of a plagioclase feldspar (usually oligoclase) and quartz, generally replacing potassium feldspar, formed during the later stages of consolidation in an igneous rock or during a subsequent period of plutonic activity. The quartz occurs as blobs, or wormlike shapes within the feldspar.

## N

**nacreous** (na'-cre-ous [nay'-cre-ous]) Pearly; having the luster of mother-of-pearl

**nadir** (na'-dir [nay'-dir]) The point on the celestial sphere that is directly beneath the observer and directly opposite the *zenith*.

**nahcolite** (nah'-co-lite) A white monoclinic mineral  $\text{NaHCO}_3$ .

**nannofossil** (nan'-no-fos-sil) 1. A collective term for fossil *discoasters* and *coccoliths*, both primarily calcareous microfossils, near the limit of resolution of the light microscope and hence best studied with electron microscopy 2. A term sometimes used in a more general sense for other marine (usually algal) fossils, smaller than *microfossils*

**nannoplankton** (nan-no-plank'-ton) Plankton in the size range 5 to 60 micrometers, defined as uncatchable in standard plankton nets.

**nappe** A sheetlike, allochthonous rock unit that has moved in a predominantly horizontal surface. The mechanism may be thrust faulting, recumbent folding, or gravity sliding. Syn *decke*

**native element** (na'-tive) Any element found uncombined in a non-gaseous state in nature. Nonmetallic examples are carbon, sulfur, and selenium, semimetal examples are antimony, arsenic, bismuth, and tellurium, *native metals* include silver, gold, copper,

iron, mercury, indium, lead, palladium, and platinum.

**native metal** A metallic *native element*.

**native paraffin** *ozocerite*

**natrolite** (nat'-ro-lite) An orthorhombic mineral of the zeolite group,  $\text{Na}_2\text{Al}_2\text{Si}_3\text{O}_{10} \cdot 2\text{H}_2\text{O}$

**natural arch** (nat'-u-ral) 1. *natural bridge*. 2. An archlike mass of rock on the face of a cliff, formed by differential weathering

**natural bridge** 1. Any archlike rock formation created by erosive agencies and spanning a ravine or valley, as at Rainbow Bridge, Utah 2. In a limestone terrane, a remnant of the roof of an underground cave or tunnel that has collapsed 3. *sea arch*; *natural arch*

**natural coke** Coal that has been naturally carbonized by contact with or proximity to an igneous intrusion, or by natural combustion. Cf. *clinker*; *coke*.

**natural gas** 1. Hydrocarbons that exist as a gas or vapor at ordinary pressures and temperatures. Methane is the most important, but ethane, propane, and others may be present. Common impurities include nitrogen, carbon dioxide, and hydrogen sulfide. Natural gas may occur alone or associated with oil. Syn *gas* 2. Gaseous hydrocarbons trapped in the zone of ground-water saturation, under pressure from, and partially dissolved in, underlying water or petroleum, *included gas*.

**natural-gas liquids** Hydrocarbons that occur naturally in gaseous

form or in solution with oil in the reservoir, and that are recoverable as liquids by condensation or absorption, e.g. *condensate* and *liquefied petroleum gas*.

**natural levee** 1 A ridge or embankment of sand and silt, built by a stream on its flood plain along both banks of its channel, esp. in time of flood when water overflowing the normal banks is forced to deposit the coarsest part of its load. **Syn.** *levee* 2 Any naturally produced low ridge resembling a natural levee, e.g. a lava levee or a sediment ridge bordering a fan-valley.

**natural mold** The empty space or cavity left after solution of a fossil shell or other organic structure, bounded by the external impression (external mold) and the surface of the internal filling (steinkern). See also *mold cast*.

**natural selection** The process by which less vigorous or less well adapted individuals tend to be eliminated from a population so that they tend to leave fewer descendants to perpetuate their stock.

**natural tunnel** A cave that is nearly horizontal and that is open at both ends. It may contain a stream. **Syn.** *tunnel*.

**nautilicone** (nau'-til-i-cone) A strongly involute nautiloid conch (like that of *Nautilus*) coiled in a plane spiral with the outer whorls embracing the inner whorls.

**nautiloid** (nau'-ti-loid) Any cephalopod characterized by a centrally located siphuncle and by a

straight, curved, or coiled chambered external shell with less elaborate sutures than in ammonoids. Nautiloids, known today only from the genus *Nautilus*, reached their peak in the Ordovician and Silurian Range, Upper Cambrian to present—adj. Pertaining to the subclass Nautiloidea.

**neanic** (ne-an'-ic) Said of a youthful or immature growth stage of an organism, the stage following the *neptonic* stage and preceding the adult stage.

**neap tide** A tide occurring at the first and third quarters of the moon, when the gravitational pull of the sun opposes (or is at right angles to) that of the moon, and having an unusually small or reduced tide range (usually 10-30% less than the mean range). Cf. *spring tide*.

**Nebraskan** (Ne-bras'-kan) Pertaining to the classical first glacial stage of the Pleistocene Epoch in North America, followed by the Aftonian interglacial stage. See also *Gunz*.

**neck** 1 A narrow strip of land connecting two larger areas, e.g. an isthmus. 2 *meander neck*. 3 *volcanic neck*. 4 An ore-bearing pipe. 5 The narrow band or "rip" of water forming the part of a rip current where *feeder currents* converge and flow swiftly through the incoming breakers or surf and out to the head.

**neck cutoff** A meander cutoff formed where a stream breaks through or across a narrow mean-

der neck, as where downstream migration of one meander has been slowed and the next meander upstream has overtaken it. Cf: *chute cutoff*.

**needle** (nee'-dle) 1 A needle-shaped or acicular mineral crystal. 2 A pointed, elevated, and detached mass of rock formed by erosion, such as a *stack*. 3. A magnetic needle.

**negative** (neg'-a-tive) Said of uniaxial crystals in which the ordinary index of refraction is greater than the extraordinary index; and of biaxial crystals in which the intermediate index of refraction  $\beta$  is closer to the highest index,  $\gamma$ , than to the lowest index,  $\alpha$ . See also: *optical character*.

**negative area** *negative element*.

**negative element** A portion of the earth's crust characterized through a long period of geologic time by repeated subsidence, or by uplift that was much less rapid or less frequent than that of adjacent *positive elements*. Syn: *negative area*. Cf: *basin*.

**negative elongation** As seen in thin section, elongation of an anisotropic crystal that is parallel to the faster of the two plane-polarized light rays Cf: *positive elongation*.

**negative movement** Subsidence of a part of the earth's crust, actual in relation to sea level or relative in relation to adjacent parts of the crust. Cf: *positive movement*.

**negative shoreline** *shoreline of emergence*.

**nekton** Aquatic animals that are

actively free-swimming, e.g. cephalopods, fish. Adj: *nektonic*.

**nektonic** (nek-ton'-ic) Said of any type of organism that actively swims; adj. of *nekton*. Cf: *planktonic*.

**nematoblastic** (nem-a-to-blas'-tic)

Pertaining to a type of even grained texture in metamorphic rocks resulting from development during recrystallization of slender parallel prismatic crystals, e.g. of actinolite.

**Neocene** (Ne'-o-cene) An obsolete syn. of *Neogene*.

**neo-Darwinism** (neo-Dar'-win-ism) Darwinism modified in accordance with modern genetics.

**Neogene** (Ne'-o-gene) An interval of time incorporating the Miocene and Pliocene of the Tertiary period, the later Tertiary. When the Tertiary is designated as an era, then the Neogene, together with the *Paleogene*, may be considered to be its two periods. Obsolete syn: *Neocene*.

**Neolithic** (Ne-o-lith'-ic) n. In archaeology, the last division of the *Stone Age*, characterized by the development of agriculture and the domestication of farm animals. Syn: *New Stone Age*. —adj. Pertaining to the Neolithic.

**neomagma** (ne-o-mag'-ma) A magma formed by partial or complete fusion of pre-existing rock under conditions of plutonic metamorphism. Cf: *anatexis*; *peltingensis*.

**neomineralization** (ne'-o-min'-er-al-i-za'-tion) Chemical interchange within a rock resulting in alteration of its mineral compo-

nents and production of new minerals. It is a type of recrystallization.

**neontology** (ne-on-tol'-o-gy) The study of existing organisms, as opposed to *paleontology*. Approx syn: *biology*.

**nepheline** (neph'-e-line) A hexagonal mineral of the feldspathoid group:  $(\text{Na}, \text{K})\text{AlSi}_3\text{O}_8$ . It occurs as glassy crystals or colorless grains, or as coarse crystals or masses, in alkalic igneous rocks, and is an essential constituent of some sodium-rich rocks.

**nepheline syenite** A plutonic rock composed essentially of alkali feldspar and nepheline; it may contain an alkali ferromagnesian mineral, e.g. an amphibole (riebeckite, arfvedsonite, barkevikite) or a pyroxene (acmite or acmite-augite). It is the intrusive equivalent of *phonolite*. Soda-lime, anorthite, hauyne, and nosean, in addition to apatite, sphene, and opaque oxides, are common accessories. Rare minerals are also frequent.

**nephelinitite** (neph'-e-lin-ite) A fine-grained or porphyritic extrusive or hypabyssal rock, of basaltic character, but primarily composed of nepheline and clinopyroxene, esp. titaniferous augite, and lacking olivine and feldspar.

**nephrite** (neph'-rite) An exceptionally tough, compact, fine-grained, greenish or bluish tremolite or actinolite, constituting the less rare kind of jade and formerly worn as a remedy for kidney diseases.

**neptunic** (nep-i-on'-ic) Said of the

stage or period in which the young shell of an invertebrate does not yet show distinctive specific characteristics, following the *embryonic* stage and preceding the *neanic* stage.

**neptunism** (nep'-tun-iam) The theory, advocated by A. G. Werner and long since obsolete, that the rocks of the earth's crust all consist of material deposited from, or crystallized out of, water. See also *Wernerian*. Cf. *plutonism*.

**neptunist** (nep'-tun-ist) A believer in the theory of neptunism. Ant. *plutonist*. Syn. *Wernerian*.

**nerite** (ne'-re-ite) A trace fossil, probably a trail formed by a worm or gastropod.

**neritic** (ne-rit'-ic) Pertaining to the ocean environment or *depth zone* between low-tide level and 100 fathoms, or approximately the edge of the continental shelf; also, pertaining to the organisms living in that environment.

**nesosilicate** (nes'-o-sil'-i-cate) A class or structural type of *silicate* characterized by isolated  $\text{SiO}_4$  tetrahedra, rather than by linkage of tetrahedra by the sharing of common oxygens. An example is olivine,  $(\text{Mg}_2\text{SiO}_4 \cdot \text{Fe}_2 + 2\text{SiO}_4)$ .

**nested** 1. Said of volcanic cones, craters, or calderas that occur one within another. 2. Said of two or more calderas that intersect, having been formed at different times or by different explosions.

**net** 1. In structural petrology, a stereographic or equal-area projection of a sphere in which the network of meridians and paral-

leis forms a coordinate system. It is used to plot points that represent lineations, the normals to foliation, or crystallographic directions. 2 A series of surveying or gravity stations interconnected in such a way that closed loops or circuits are formed or so arranged as to provide a check on the consistency of the measured values. *Syn network*. 3 A form of horizontal patterned ground with a mesh intermediate between a circle and a polygon.

**net balance** The change in mass of a glacier from the time of minimum mass in one year to the time of minimum mass in the succeeding year, the mass change between one summer surface and the next. Cf. *balance*.

**net slip** On a fault, the distance between two formerly adjacent points on either side of the fault measured on the fault surface or parallel to it. It defines both the direction and relative amount of displacement. Cf. *horizontal slip*, *vertical slip*.

**network net**

**neutral shoreline** (neu'-tral) A shoreline whose essential features are independent of either the submergence of a former land surface or the emergence of a former underwater surface, a shoreline resulting without a change in the relative level of land and water. It includes shorelines of deltas, alluvial and outwash plains, volcanoes, and coral reefs, as well as those produced by faulting.

**neutral stress** The stress transmit-

ted by the fluid that fills the voids between particles of a soil or rock mass, e.g. that part of the total normal stress in a saturated soil caused by the presence of interstitial water. *Syn pore pressure*.

**neutral surface** *surface of no strain*.

**neutron-activation log** (neu'-tron ac-ti-va'-tion) A *radioactivity log* of neutron-spectral gamma type usually run in cased wells, in which high-energy neutrons (about 14 Mev) bombard well bore rocks and transmute natural elements to gamma ray-emitting isotopes of characteristic identity. Behavior of calcium versus silicon permits lithology interpretation, and that of carbon versus oxygen may distinguish oil from water. See also *spectral gamma ray log*.

**neutron-gamma log** The *well log* curve of induced gamma radioactivity that results from bombardment of rocks near the well bore by fast neutrons. A low count rate implies near-source dissipation in high-porosity rocks, esp. capture by chlorine. See also *neutron log*.

**neutron log** A *radioactivity log* curve that indicates the intensity of radiation (neutrons or gamma rays) produced when the rocks in a borehole are bombarded by neutrons from a *sonde*. It indicates the presence of fluids (but does not distinguish between oil and water) in the rocks, and is used with the gamma-ray log to differentiate porous from nonporous formations. See also *neutron gamma log*.

**Nevadan orogeny** (Ne-vad'-an) A

time of deformation, metamorphism, and plutonism during Jurassic and early Cretaceous time in the western part of the North American cordillera, typified by relations in the Sierra Nevada, California

**névé** (né-vé') 1. *firn*. 2. *firn field*  
**new global tectonics** A general term introduced in 1968 for *global tectonics* based on the related concepts of continental drift, sea floor spreading, transform faults, and underthrusting of the crust and uppermost mantle at island arcs, as they are jointly applied to an integrated analysis of the relative motions of crustal segments delineated by the major seismic belts

**New Red Sandstone** The red sandstone facies of the Permian and Triassic systems, well-developed in NW England

**New Stone Age** *Neolithic*

**Niagaran** (Ni-ag'-a-ran) Middle Silurian of North America

**niccolite** (nic'-co-lite) *nickeline*

**nickeliferous** (nick-el-í'-er-ous) Containing nickel

**nickeline** (nick'-el-ine) A pale copper-red hexagonal mineral, NiAs. It is one of the chief ores of nickel, and may contain antimony, cobalt, iron, and sulfur. Syn. *niccolite*.

**nickpoint** *knickpoint*.

**Nicol prism** In a polarizing microscope, one of a pair of prisms that polarize and analyze the light used for study of a thin section. The lower nicol, or *polarizer*, is located below the stage; it con-

sists of a rhombohedron of optically clear calcite so cut and recombined that the ordinary ray produced by double refraction in the calcite is totally reflected and the extraordinary ray is transmitted. The upper nicol, or *analyzer*, is located above the objective and receives the polarized light after it has passed through the object under study. Its vibration direction is normally set at right angles to that of the polarizer. Partial syn.: *nicol*

**Niggli's classification** A classification of rocks on the basis of their chemical composition, similar in some respects to the *CIPW classification*.

**nip** 1. A small, low break in slope on a beach, produced at the high-water mark by wavelets. 2. A horizontal cavity formed in soluble rock at the edge of a water body. 3. A *pinch* or thinning of a coal seam, esp. as a result of tectonic movement.

**niter** (ni'-ter) A white orthorhombic mineral, KNO<sub>3</sub>. It is a soluble crystalline salt that occurs as a product of nitrification in most arable soils in hot, dry regions, and in the loose earth forming the floors of some natural caves. Cf. *soda niter*. Syn. *saltpeter*.

**nitrate** (ni'-trate) A mineral compound characterized by a fundamental anionic structure of (NO<sub>3</sub>)<sup>-1</sup>. Soda niter, NaNO<sub>3</sub>, and niter, KNO<sub>3</sub>, are examples. Cf. *carbonate*; *borate*.

**nitride** (ni'-tride) A compound of nitrogen with a more positive ele-

ment. An example is osbornite,  $TiN$ .

**nival** (ni'-val) Characterized by or living in or under snow, e.g. a nival climate or fauna

**nivation** (ni'-va'-tion) 1 Frost action and mass-wasting beneath a snowbank. 2. The work of snow and ice beyond the limits of glacier action.

**noble metal** Any metal or alloy of comparatively high value, or superior in certain desired properties, e.g. gold, silver, or platinum (*cf. base metal*).

**node** 1 A knob, protuberance, or thickened body part of an animal. 2 The point on a fault at which the apparent displacement changes. 3. That point on a standing wave at which the vertical motion is least and the horizontal velocity is greatest, e.g. one of the stationary points on a vibrating string.

**nodular** (nod'-u-lar) 1 Composed of nodules, e.g. a nodular limestone. 2. Having the shape of nodules, e.g. a nodular ore.

**nodule** (nod'-ule) 1 A small rounded mass or lump of a mineral or mineral aggregate, normally without internal structure, contrasting in composition with the rock matrix in which it is embedded; e.g. a nodule of pyrite in coal or of chert in limestone. *Cf. concretion*. 2. One of the widely distributed concretionary lumps of manganese and other metals, found on the floors of the world's oceans.

**nodes** In seismic prospecting, all re-

corded energy not derived from the explosion of the shot. Sometimes it is loosely used for all recorded energy except events of interest.

**nomenclature** (no'-men-cla-ture) The practice of naming allied groups of plants and animals (*taxa*) according to the hierarchical system and formal procedure prescribed by accepted authoritative codes, i.e. the International Code of Botanical Nomenclature and the International Code of Zoological Nomenclature.

**nominal diameter** (nom'-i-nal) The computed diameter of a hypothetical sphere having the same volume as that calculated for a given sedimentary particle. It is a true measure of particle size independent of either shape or density of the particle. *Cf. equivalent radius*.

**nonartesian ground water** (non-ar-te'-sian) *unconfined ground water*.

**nonconformity** (non-con-form'-i-ty) An unconformity between stratified rocks above and unstratified igneous or metamorphic rocks below.

**nonflowing artesian well** An *artesian well* whose head is not sufficient to lift the water above the land surface. *Cf. flowing artesian well*.

**nonmetal** (non-met'-al) 1. A naturally occurring substance that does not have metallic properties such as high luster, conductivity, opaqueness, and ductility. 2. In economic geology, any rock or mineral mined for its nonmetallic





comparson Adj: *normative*. Cf: *mode*

**normal cycle** *fluvial cycle of erosion*.

**normal dip** *regional dip*

**normal distribution** A *frequency distribution* whose plot is a continuous, infinite, bell-shaped curve that is symmetrical about its arithmetic mean, mode, and median (which in this distribution are numerically equivalent) Syn: *Gaussian curve*.

**normal erosion** 1 The wearing-away of topographic features by prevailing agencies, specif stream erosion in a temperate climate. The term is open to criticism because erosion as found in temperate areas may in fact be "abnormal" or because one mode of erosion is just as "normal" as another. 2 Erosion under natural environmental conditions, undisturbed by human activity.

**normal fault** A fault in which the hanging wall appears to have moved downward relative to the footwall. The angle of dip is usually 45-90° Cf: *thrust fault*. Syn: *gravity fault*, *slump fault*.

**normal horizontal separation** *offset*.

**normal moveout** The increase in arrival time of a seismic-reflection eve it resulting from an increase in the distance from source to detector, or from dip of the reflector. Seismic data must be corrected for normal moveout. See also *moveout*.

**normal-moveout velocity** The constant velocity for an overlying

medium that would most nearly give the observed normal moveout for a horizontal reflector. It is determined from normal moveout values in *velocity analysis*.

**normal polarity** 1. A natural remanent magnetization closely parallel to the present ambient geomagnetic-field direction. See also: *geomagnetic reversal*. 2. A configuration of the earth's magnetic field with the magnetic negative pole located near the geographic north pole.—Cf: *reversed polarity*.

**normal stress** That component of stress which is perpendicular to a given plane. It may be either *tensile stress* or *compressive stress*.

**normal zoning** In plagioclase, the change by which crystals become more sodic in their outer parts Cf: *reversed zoning*.

**normative** (nor-ma-tive) The adj of *norm*.

**normative mineral** A mineral whose presence in a rock is theoretically possible on the basis of certain chemical analyses. A normative mineral may or may not actually be present. See also: *norm*. Syn: *standard mineral*.

**norm system** *CIPW classification*.

**nose** 1. A short, plunging anticline without closure. 2. A projecting buttress of rock, or of a ridge or mountain. 3. The central forward part of a parabolic dune. 4. The forward part of a turbidity current, which is denser than the tail and carries coarser material.

**notch** 1. A term used in the northeastern U.S. for a narrow

defile between mountains or through a ridge Cf *gap col 2* A deep cut along the base of a sea cliff near the high water mark, formed by wave erosion, over which the cliff hangs Cf *nip*

**notochord** (no-to'chord) A rod of elastic cells which provides a supporting and stiffening structure in an animal's body; it is replaced by a backbone in the true vertebrates

**novaculite** (no-vac'u-lite) A dense, hard, crystalline, light-colored, cryptocrystalline, siliceous sedimentary rock similar to chert but for the dominance of microcrystalline quartz over chert nodules. Large type occur once (lower Paleozoic) in the Ouachita Mountains, Arkansas and Oklahoma; it appears to be a thermal metamorphosed bed of chert. The rock is used as a waterstone. See also *Arkansas stone*

**nuclear log** (nu'cle-ar [no'kle-er]) Cf *neutron log 2 radioactivity log*

**nucleation** (nu-cle-ation) The beginning of crystal growth at one or more points

**nucleide** (nu-'clue) A species of isotope characterized by the number of neutrons and protons in its nucleus

**nuée ardente** (nu-ee-ar'den-te) A swift, flowing, turbulent gaseous cloud, sometimes incandescent,

erupted from a volcano and containing ash and other pyroclastics in its lower part a *density current* of pyroclastic flow. The lower part of the nuée ardente is comparable to an *ash flow* and the terms are sometimes used synonymously. Etymol. French, "glowing cloud." Syn. *growing cloud*

**nugget** A waterworn lump of placer gold or other metal

**nummulite** (num-mu-lite) Any foraminifer belonging to the family Nummulitidae, characterized by a planispiral conic or lens-shaped test. Range: Upper Cretaceous to the present. Adj. *nummulitic*

**nummulitic limestone** (num-mu-lit'ic) A sedimentary rock composed chiefly of nummulite shells, specific to the "Nummulitic Limestone" of thick, distinctive, and widely distributed Eocene formation stretching from the Alps and northern Africa to China and eastern and southern Asia, comprising especially the remains of the genus *Nummulites*

**nunatak** (nu-'a-tak) An isolated knob or peak of rock that projects prominently above the surface of a glacier and is surrounded by glacier ice. Nunatak is common along the coast of Greenland and Fennoscandia. Etymol. Eskimo, "loose peak"

## O

**oblique** (ob-lique') *n* An aerial photograph taken with the camera axis intentionally inclined. It combines the ground view with the pattern obtained from a height. See also: *high oblique*, *low oblique*.

**oblique extinction** *inclined extinction*.

**oblique fault** A fault that strikes oblique to, rather than parallel or perpendicular to, the strike of the constituent rocks or dominant structure. Cf: *oblique-slip fault*. Syn: *diagonal fault*.

**oblique joint** *diagonal joint*.

**oblique projection** A projection that is not centered on a pole or on the equator and that does not use the equator or a meridian as a center line of orientation, or that has an axis inclined at an oblique angle to the equatorial plane, e.g. "oblique Mercator projection".

**oblique-slip fault** A fault in which the slip is oblique to, rather than parallel or perpendicular to, the dip of the constituent rocks or dominant structure. Cf: *oblique fault*. Syn: *diagonal-slip fault*.

**obsequent** (ob'-se-quent) *adj* 1. Said of a geologic or topographic feature that does not resemble or agree with a *consequent* feature from which it developed; e.g. a block mountain that was formerly the floor of a graben but was left standing as a result of differential erosion. 2. Said of a stream or valley whose course is opposite to

that of the original consequent drainage.—*n.* *obsequent stream*.

**obsequent fault-line scarp** A *fault-line scarp* that faces in the opposite direction from the original fault scarp, i.e. faces the up-thrown block. Cf: *resequent fault-line scarp*.

**obsequent stream** A stream that flows in a direction opposite to that of an original consequent stream and that is a tributary to a subsequent stream developed along the strike of weak beds; e.g. a short stream flowing down the scarp slope of a cuesta. Syn: *oblique*.

**obsidian** (ob-sid'-i-an) A black or dark-colored volcanic glass, usually of rhyolite composition, characterized by conchoidal fracture. It has been used for making arrowheads, jewelry, and art objects.

**obtuse bisectrix** The direction bisecting the obtuse angle between the optic axes of a biaxial crystal. Cf: *acute bisectrix*.

**ocean-basin floor** The area of the sea floor between the base of the continental margin, usually the foot of the continental rise, and the mid-ocean ridge.

**ocean current** 1. A predominantly horizontal movement of the surface water of the ocean, constituting part of its general circulation.

2. Broadly, any current in the ocean—tidal or nontidal, permanent or seasonal, horizontal or vertical—characterized by regularity. It may be produced by wind stresses, long-wave motions,

or density gradients.

**oceanic crust** The crustal rocks that underlie the ocean basins; they are equivalent to the *sima*. The oceanic crust is about 5-10 km thick; it has a density of 3.0 g/cm<sup>3</sup>, and compressional seismic-wave velocities travelling through it exceed 6.2 km/sec. Cf: *continental crust*.

**oceanography** (o-cean-og'-ra-phy)

The study of the ocean, including its boundaries and bottom topography, the physics and chemistry of sea water, the types of currents, and the many phases of marine biology.

**ocellar** (o-cel'-lar) Said of the texture of an igneous rock in which aggregates of smaller crystals (e.g. biotite) are arranged radially or tangentially around larger, euhedral crystals (e.g. leucite) or form rounded eyelike branching forms. Also said of a rock having such a texture.

**ocher** (o'-cher) An earthy, powdery, red, yellow, or brown iron oxide that is used as a pigment; e.g. yellow or brown ocher (limonite) and red ocher (hematite). Also, any of various clays strongly colored by iron oxides. Cf: *umber*; *sienna*. Also spelled: *ochre*.

**Ochoan** (O'-cho-an) Uppermost Permian of North America.

**octahedral cleavage** (oc-ta-he'-dral) Mineral cleavage parallel to the faces of the octahedron, as in fluorite.

**octahedrite** (oc-ta-he'-drite) *anatase*.

**octahedron** (oc-ta-he'-dron) In the isometric system, a crystal form consisting of eight triangular faces each having equal intercepts on all three crystallographic axes.

**offlap** 1. The progressive offshore regression of the updip edges of sedimentary units within a conformable sequence of rocks, in which each successively younger unit leaves exposed a portion of the older unit on which it lies. Ant: *onlap*. Syn: *regressive overlap*. 2. The progressive withdrawal of a sea from the land. Cf: *regression*. 3. A term commonly used by seismic interpreters for reflection patterns generated from strata prograding into deep water.

**offset** 1. The horizontal component of displacement on a fault, measured perpendicular to the disrupted horizon. Syn: *normal horizontal separation*. 2. In seismic prospecting, the horizontal distance from energy source nearest detector, or from a shothole to the line of profile (measured perpendicularly to the line); also, the horizontal displacement, measured from the detector, of a point for which a calculated depth applies. 3. A spur or minor branch from a range of hills or mountains. 4. A new corallite formed in a corallum by budding.

**offset well** An oil well drilled near the boundary of a property and opposite to a producing or completed well on an adjoining property, for the purpose of preventing the drainage of oil or gas by the

earlier well. An obligation to drill such offset wells is contained in oil and gas leases.

**offshore bar** 1. *longshore bar*. 2. A catchall term for features now known as *barrier beach* and *barrier island*. --The term is undesirable as it has been applied both to a submerged feature (bar) and an emergent feature (barrier).

**offshore beach** *barrier beach*.

**ogive** (o'-give [o'-jive]) A dark band of debris-laden ice, one of a series visible on a glacier surface, convex downslope owing to faster flow in the middle of the glacier.

**oil field** 1. An *oil pool*. 2. Two or more oil pools on a single geologic feature or otherwise closely related.

**oil pool** A subsurface accumulation of petroleum that will yield crude oil in economic quantities. (The oil occurs in the pores of the rock and is not a "pool" in the ordinary sense of the word.) Cf. *oil field*.

**oil sand** A term applied loosely to any porous stratum containing petroleum or impregnated with hydrocarbons, specif. a sandstone or unconsolidated sand from which oil is obtained by drilled wells. The term is also applied to productive limestone and dolomite. See also *gas sand*; *tar sand*.

**oil shale** A *kerogen*-bearing, finely laminated brown or black sedimentary rock that will yield liquid or gaseous hydrocarbons on distillation. Syn: *kerogen shale*.

**oil trap** Any barrier to the upward movement of oil or gas, allowing

either or both to accumulate. A trap includes a *reservoir rock* and an impermeable *roof rock*; the contact between these is concave downward. See also: *stratigraphic trap*; *structural trap*.

**oil-water contact** The boundary surface between an accumulation of oil and the underlying "bottom water". Syn: *oil-water interface*.

**oil-water interface** *oil-water contact*.

**old age** 1. That stage in development of a stream in which erosion decreases and aggradation becomes dominant; the stream meanders on a broad floodplain. 2. The final stage in the cycle of erosion of a region, in which the surface has been reduced almost to base level. 3. A hypothetical stage in the development of a coast, characterized by a wide wave-cut platform, a gently sloping sea cliff far inland, and a coastal region nearly a peneplain. The stage is probably an abstraction, since it is doubtful whether sea level remains stable long enough for the land to be so reduced.

**Old Red Sandstone** A thick sequence of nonmarine, predominantly red sedimentary rocks, chiefly sandstones, conglomerates, and shales, representing the Devonian System in parts of Great Britain and elsewhere in NW Europe.

**Old Stone Age** *Paleolithic*.

**oligo-** A prefix meaning "few", "a little".

**Oligocene** (Ol'-i-go-cene) Aa

epoch of the early Tertiary period, after the Eocene and before the Miocene; also, the corresponding worldwide series of rocks. It is considered to be a period when the Tertiary is designated as an era.

**oligoclase** (ol'-i-go-clase) A mineral of the plagioclase feldspar group with composition ranging from  $Ab_{90}An_{10}$  to  $Ab_{70}An_{30}$ . It is common in igneous rocks of intermediate to high silica content.

**oligomictic** (ol'-i-go-mic'-tic) 1. Said of a lake that circulates only at rare intervals when abnormally cold spells occur, e.g. a lake of small or moderate area or of very great depth. 2. Said of a clastic sedimentary rock composed of only a few rock types, e.g. a feldspathic quartz arenite; also, said of the clasts of such a rock. Cf: *monomictic*; *polymictic*.

**oligotrophic lake** (ol'-i-go-troph'-ic) A lake that is characterized by a deficiency in plant nutrients and usually by abundant dissolved oxygen in the bottom layers; its bottom deposits have relatively small amounts of organic matter and its water is often deep. Cf: *dystrophic lake*; *eutrophic lake*.

**olistostrome** (o-lis'-to-strome) A sedimentary deposit consisting of a chaotic mass of intimately mixed heterogeneous materials (such as blocks and muds) that accumulated as a semifluid body by submarine gravity sliding or slumping of unconsolidated sediments. It is a mappable, lens-like stratigraphic unit lacking true

bedding but intercalated among normally bedded sequences, as in the Tertiary basin of central Sicily. Cf: *mélange*.

**olivine** (ol'-i-vine) A green or brown orthorhombic mineral,  $(Mg,Fe)_2SiO_4$ . It consists of the isomorphous solid-solution series forsterite-fayalite. Olivine is a common rock-forming mineral of basic, ultrabasic, and low-silica igneous rocks (gabbro, basalt, peridotite, dunite); it crystallizes early from a magma, weathers readily at the earth's surface, and metamorphoses to serpentine. See also: *peridot*; *chrysolite*.

**oncolite** (on'-co-lite) A concentrically laminated, calcareous sedimentary structure, resembling an oolith, formed by the accretion of successive layered masses of gelatinous sheaths of blue-green algae. It is smaller than a *stromatolite* and generally does not exceed 10 cm in diameter.

**onion-skin weathering** *spheroidal weathering*.

**onlap** 1. An overlap characterized by the regular and progressive pinching out, toward the margins or shores of a depositional basin, of the sedimentary units within a conformable sequence of rocks, in which the boundary of each unit is transgressed by the next overlying unit and each unit in turn terminates farther from the point of reference. Ant: *offlap*. Cf: *overstep*. Syn: *transgressive overlap*. 2. The progressive submergence of land by an advancing sea. Cf: *transgression*.

**onshore 1.** Pertaining to a direction landward from the sea, as an onshore wind. **2.** Situated on or near the shore, as onshore oil reserves.

**ontogenetic stage** (on'-to-ge-net'-ic) Developmental stage in the growth of an individual organism.

**ontogeny** (on tog'-e ny) Development of an individual organism in its various stages from initiation through maturity. Adj. *ontogenetic*. Cf. *phylogeny*. See *life cycle*.

**onyx** A variety of banded onyx that is like banded agate in consisting of alternating bands of different colors but unlike agate in that the bands are always straight and parallel to each other and are usually translucent. It is a variety of agate composed of alternating layers of agate and onyx, resembling the eyes of a peacock. It is capable of taking a good polish and used as a decorative or architectural material. It is usually deposited from cold-water solutions, often in the form of stalagmites and stalactites in caves. See also *cave onyx*. Syn. *onyx alabastrum*.

**oolite** (o'-o-lite) **1.** A sedimentary rock, usually a limestone, made up chiefly of ooliths cemented together. **2.** A term often used for *oolith*. Cf. *pisolite*.

**oolith** (o'-o-lith) One of many small rounded accretionary bodies in a sedimentary rock, resembling fish eggs, with a diameter of 0.25 to 2.0 mm. It is generally

formed of calcium carbonate, in concentric layers around a nucleus such as a sand grain. The term is sometimes used for a rock composed of ooliths. Cf. *ochite*, *pisolith*.

**ooze** A pelagic sediment consisting of at least 30% skeletal remains of calcareous or siliceous pelagic organisms, the rest being clay minerals. Oozes are defined by the characteristic organisms, e.g. diatom ooze. See also *calcareous ooze*, *siliceous ooze*.

**opal** A mineral form of  $\text{SiO}_2 \cdot n\text{H}_2\text{O}$ . It has been shown to be electrically conductive in some packed spheres of colloidal water content, usually the "opal" color form, which is transparent and colorless and commonly exhibits a play of color (the dependence of its refractive index and color on the wavelength of incident light). The transparent colorless varieties showing opalescence are valued as gemstones. See also *hyalite*.

**opalescence** (o-pal-es-ence) A milky or somewhat pearly appearance or luster of a mineral, such as that shown by opal and moonstone. Cf. *play of color*.

**opalized wood** (o'-pal-ized) *silicified wood*.

**opaque** (o-paque) Said of a material that is impervious to visible light, or to radiant energy other than visible light, e.g. radiation. Cf. *translucent*; *transparent*.

**open-cut mining** Surficial mining, in which the valuable rock is exposed by removal of overburden



Coal, numerous nonmetals, and metalliferous ores (as of iron and copper) are worked in this way

Syn *strip mining*

**open fold** A fold in which the limbs diverge at a large angle

**open form** A crystal form whose faces do not enclose space e.g. a trigonal prism Cf. *closed form*

**open hole** An uncased well or borehole or that portion extending below the depth at which casing has been set 2 A borehole free of any obstructing object or material

**open packing** The measure of the element of a crystal solid which packs as closely as possible in a cubic lattice, as in the case of a face-centered cubic packing

**openure** open (cal) A term used in the context of openure in the context of openure

**ophite** (o-phi'te) A term used in the context of ophite in the context of ophite

**ophiolite** (o-phi'o-lite) An assemblage of mafic and ultramafic igneous rocks ranging from spilite and basalt to gabbro and peridotite including rocks rich in serpentine, chlorite, epidote, and albite derived from them by later metamorphism, whose origin is associated with an early phase of the development of a geosyncline

**ophitic** (o-phi'tic) Said of the texture of an igneous rock, esp. diabase, in which lath-shaped plagioclase crystals are included in pyroxene crystals, typically augite Also, said of a rock exhibiting such a texture. Cf. *poikilitic*.

Syn: *diabasic; doleritic*.

**optical calcite** (op'-ti-cal) Crystalline calcite so clear that it has value for optical use It is usually *Ice-land spar*

**optical character** In optical crystallography, the designation positive or negative, depending on the values of the different indices of refraction of a mineral For uniaxial crystals with two indices of refraction, if the index of the extraordinary ray exceeds that of the ordinary ray the mineral has a positive optical character For biaxial crystals with three indices of refraction, the intermediate index is nearer in value to the smaller index than to the larger one for optically positive crystals

**optical constant** Any characteristic optical property of a crystal, e.g. index of refraction, optic angle

**optical pyrometer** An instrument that measures high temperature by comparing the intensity of light of a particular wavelength from the hot material with that of a filament of known temperature It is used to determine the temperature of incandescent lavas

**optic angle** The acute angle between the two optic axes of a biaxial crystal, its symbol is  $2V$  Syn *axial angle*

**optic axis** A direction in an anisotropic crystal along which there is no double refraction

**optic ellipse** Any noncircular section of an *indicatrix*

**orbicular** (or-bic'-u-lar) 1. Said of the structure of a rock containing numerous orbicules, also, said of

a rock having such structure. 2. Having the shape of an orbicule.

Cf: *spherulitic*.

**orbicule** (or'-bi-cule) A more or less spherical body, from microscopic size to several centimeters in diameter, whose components are arranged in concentric layers.

Cf: *spherulite*. Adj: *orbicular*.

**order 1.** A category in the hierarchy of classification of plants and animals intermediate between *class* and *family*. 2. In the CIPW classification of igneous rocks, the basic unit of the *class*. 3. *basin order*. 4. *stream order*.

**order-disorder polymorphism** The occurrence of two crystal substances of the same composition but different atomic arrangement. In the higher-temperature or disordered form, two or more elements are randomly distributed over a particular set of atom sites; in the lower-temperature or ordered form, the atoms become ordered with respect to the same sites. The ordered form usually has lower symmetry.

**order of crystallization** The apparent chronological sequence in which crystallization of the various minerals of an assemblage takes place, as evidenced mainly by textural features.

**ordinary lead** (or'-di-nar-y) *common lead*.

**ordinary ray** In uniaxial crystals, the ray that vibrates perpendicular to the optic axis; the *O ray*. Cf: *extraordinary ray*.

**Ordovician** (Or-do-vi'-cian) The second earliest period of the

Paleozoic era (after the Cambrian and before the Silurian), thought to have covered the span of time between 500 and 440 million years ago; also, the corresponding system of rocks. It is named after a Celtic tribe called the Ordovices. See also: *age of marine invertebrates*.

**ore** The naturally occurring material from which a mineral or minerals of economic value can be extracted at a reasonable profit. Also, the mineral(s) thus extracted. The term is generally but not always used to refer to metalliferous material, and is often modified by the name of the valuable constituent, e.g., "iron ore". See also: *mineral deposit*; *ore body*; *ore mineral*.

**orebody** A continuous, well-defined mass of material containing enough ore to make extraction economically feasible. See also: *mineral deposit*.

**ore control** Any tectonic, lithologic, or geochemical feature considered to have influenced the formation and localization of ore.

**ore magma** A magma that may crystallize into an ore; the sulfide, oxide, or other metallic facies of a solidified magma.

**ore mineral** The part of an *ore*, usually metallic, which is economically desirable, as contrasted with the *gangue*.

**ore shoot** A pipe-like, ribbonlike, or chimneylike mass of ore within a deposit (usually a vein), representing the more valuable part of the deposit. Syn: *shoot*.

**organic** (or-gan'-ic) adj. Pertaining or relating to a compound containing carbon, especially as an essential component. Organic compounds usually have hydrogen bonded to the carbon atom. Cf: *inorganic*. —n. A substance containing carbon, as in such expressions as "organic-rich shale".

**organic reef** A reef or *bioherm*.

**organic rock** A sedimentary rock consisting primarily of the remains of organisms (plant or animal), such as of material that originally formed part of the skeleton or tissues of an animal. Cf: *biogenic rock*.

**organism** Any living individual whether plant or animal.

**oriental amethyst** (o-ri-en'-tal) 1. The violet to purple variety of sapphire. 2. Any amethyst of exceptional beauty.

**oriental emerald** A green variety of corundum.

**oriental topaz** A yellow variety of corundum.

**orientation** (o'-ri-en-ta'-tion) 1. In describing crystal form and symmetry, the placing of the crystal so that its crystallographic axes are in the conventional position. 2. The direction in which an aerial photograph is turned with respect to observer or map. 3. In surveying, establishing the correct relationship in direction, usually with reference to the points of the compass.

**oriented specimen** (o'-ri-ent-ed) 1. A representative piece of rock that is so marked as to show its original position in space. 2. A

fossil whose position is known as to such features as dorsal and ventral sides, axis of coiling, etc.

**original dip** *primary dip*.

**original horizontality** The state of strata being horizontal or nearly so at the time they were deposited. See also: *law of original horizontality*.

**orocline** (or'-o-cline) An orogenic belt with an imposed curvature or sharp bend, interpreted as a result of horizontal bending of the crust, or "deformation in plan".

**orocratic** (or-o-crat'-ic) Pertaining to a period of time in which there is much diastrophism.

**orogen** (or'-o-gen) *orogenic belt*.

**orogenic** (or-o-gen'-ic) Adj. of *orogeny*. Cf: *orographic*.

**orogenic belt** A linear or arcuate region that has been subjected to folding and other deformation during an orogenic cycle. Orogenic belts are *mobile belts* during their formative stages, and most of them later became mountain belts by postorogenic processes. Syn: *fold belt*; *orogen*.

**orogenic cycle** The interval of time during which an originally *mobile belt* evolved into a stabilized *orogenic belt*. The concept has been rendered obsolete by the recognition of the plate structure of the earth. Syn: *geosynclinal cycle*; *tectonic cycle*.

**orogenic facies** A term describing the tectonic environment of a *geosynclinal facies*.

**orogenic phase** The median part of an orogenic cycle, characterized by a climax of crustal mobility

and orogenic activity.

**orogeny** (o-rog'-e-ny) Literally, the process of formation of mountains. In present usage, orogeny is the process by which structures within fold-belt mountainous areas were formed, including thrusting, folding, and faulting in the outer and higher layers, and plastic folding, metamorphism, and plutonism in the inner and deeper layers. Only in the very youngest, late Cenozoic mountains is there any evident causal relation between rock structure and surface landscape. See also *diastrophism*. Cf. *epi-orogeny*. Adj. *orogenic*. Syn. *orogenesis*.  
**orogeosyncline** (or-ge-o-syn'-cline) A geosyncline that developed into an orogenic belt.

**orpiment** (or-pi-ment) A lustrous yellow to orange arsenic mineral,  $As_2S_3$ . It is generally foliated or massive, and is frequently associated with realgar. Orpiment occurs as a deposit from some hot springs and as a sublimate from some volcanoes.

**ortho-** In petrology, a prefix that, when used with the name of a metamorphic rock, indicates that it was derived from an igneous rock, e.g. orthogneiss, orthoamphibolite; it may also indicate the primary origin of a crystalline, sedimentary rock, e.g. "orthoquartzite" as distinguished from "metaquartzite".

**orthoaxis** (or'-tho-ax'-is) In a monoclinic crystal, the lateral axis that has twofold symmetry and/or is perpendicular to the

mirror plane of symmetry; it is the *b* axis. Cf. *clinoaxis*.

**orthoclase** (or'-tho-clase) 1. A white, pink, or gray mineral of the alkali feldspar group:  $KAlSi_3O_8$ . It is the partly ordered, monoclinic modification of potassium feldspar and is dimorphous with microcline, being stable at higher temperatures; it usually contains sodium in minor amounts. Orthoclase is a common rock-forming mineral; it occurs esp. in granites, and igneous rocks, and crystalline schists, and is usually perthitic. 2. A general term applied to any potassium feldspar that is or appears to be monoclinic. Cf. *plagioclase*, *anorthoclase*.

**orthodionite** (or-tho-dio'-to-mite) A primary diorite, i.e. one formed by sedimentation.

**orthogenesis** (or'-tho-gen-esis) Evolution that follows a single direction or specific trend continuously for many generations of an evolving lineage and often appears to be independent of the effects of natural selection or other external factors.

**orthogeosyncline** (or'-tho-ge-o-syn'-cline) A geosyncline between continental and oceanic cratons, containing both volcanic (eugeosynclinal) and nonvolcanic (miogeosynclinal) belts. Syn: *primary geosyncline*. See also: *eugeosyncline*; *miogeosyncline*.

**orthogneiss** (or'-tho-gneiss) A gneiss derived from an igneous rock.

**orthogonal** (or-thog'-o-nal) *n.* A curve that is everywhere perpen-

pendicular to the wave crests on a refraction diagram

**orthographic projection** (or tho-graph'ic) A perspective (azimuthal) map projection produced by straight parallel lines from a point infinitely far from the centre of the sphere and perpendicular to the plane of projection. The largest area of the sphere that can be projected is a hemisphere. The projection is used for maps of the world, and of the hemisphere of the Northern Hemisphere. It is also used for maps of the Southern Hemisphere. The projection is used for maps of the world, and of the hemisphere of the Northern Hemisphere. It is also used for maps of the Southern Hemisphere.

**orthomagnetic** (or tho-mag-net-ic) A magnetic field that is produced by a current flowing in a straight line. The field is perpendicular to the direction of the current. The field is used for magnetic levitation, and for magnetic storage.

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**orthopinacoid** (or tho-pin-a-oid) A mineral that is a member of the orthopinacoid group. It is a silicate mineral that is found in igneous rocks.

**orthoquartzite** (or tho-quar-tite) A clastic sedimentary rock composed almost entirely of siliceous cemented quartz sand. A quartzite of sedimentary origin. The cement is deposited in optical and crystallographic continuity with the detrital grains. The rock is characterized by scarcity of heavy minerals, lack of fossils and prominent cross beds and ripple marks. It commonly occurs as

thin, widespread blanket deposits associated with regional unconformities. *Syn quartzarenite Cf metquartzite*

**orthorhombic system** (or tho-rh'om-bic) One of the six crystal systems characterized by three unequal axes at right angles to each other and of unequal relative lengths. *Syn rhombic system*

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*wave of translation*. Syn: *wave of oscillation*.

**osmosis** (os-mo'-sus) The movement at unequal rates of a solvent through a semipermeable membrane, which usually separates the solvent and a solution, or a dilute solution and a more concentrated one, until the solutions on both sides of the membrane are equally strong Cf. *dialysis* See also *electro-osmosis*.

**Osteichthyes** (Os-te-ich' thy-es) A class of vertebrates, the bony fishes Range, Devonian to present

**ostracode** (os'-tra-code) Any aquatic crustacean belonging to the subclass Ostracoda, characterized by a bivalve, generally calcified carapace with a hinge along the dorsal margin Most ostracodes are of microscopic size (0.4-1.5 mm long) although freshwater forms up to 5 mm long and marine forms up to 30 mm long are known Range, Lower Cambrian to present Also spelled *ostracod*

**outcrop** n That part of a geologic formation or structure that appears at the surface of the earth, also, bedrock that is covered by surficial deposits such as alluvium Cf. *exposure* Syn *outcropping* —v To appear exposed and visible at the earth's surface, *crop out*.

**outer core** The outer or upper zone of the earth's core, extending from a depth of 2900 km to 5100 km, and including the transition zone, it is equivalent to the *E layer*

and the *F layer*. It is presumed to be liquid because it sharply reduces compressional-wave velocities and does not transmit shear waves Its density ranges from 9 to 11 g/cm<sup>3</sup> Cf. *inner core*.

**outgassing** The removal of occluded gases, usually by heating, e.g. in the earth's early history, the release of gases and water vapor from molten rocks, leading to the formation of the earth's atmosphere and oceans

**outlet glacier** A glacier issuing from an ice sheet or ice cap through a mountain pass or valley Cf. *glacial lobe*.

**outlier** An area or group of rocks surrounded by rocks of older age, e.g. an isolated hill or butte. Cf. *inlier*

**outpost well** A hole drilled for oil or gas with the thought that it will probably extend, by a considerable distance, a pool already partly developed It is far enough from the limits of the pool to make its outcome uncertain, but not far enough to be designated a *wildcat well*

**outwash** Sand and gravel deposited by meltwater streams in front of the end moraine or the margin of an active glacier

**outwash plain** A broad, gently sloping sheet of outwash deposited by meltwater streams flowing in front of or beyond a glacier, a broad body of outwash Cf. *valley train*, *glacial plain*

**overbank deposit** Silt and clay deposited from suspension on a flood plain by floodwaters that

cannot be contained within the stream channel

**overburden** (o'-ver-bur-den) 1. Loose or consolidated rock material that overlies a mineral deposit and must be removed prior to mining 2 The upper part of a sedimentary deposit, compressing and consolidating the material below 3 *regolith*

**overflow** v To flow over the margin of, to cover with water —n A flowing over the banks of a stream or river, an inundation

**overfold** An *overturned* fold

**overgrowth** 1 Mineral material deposited in optical and crystallographic continuity around a crystal grain of the same composition, as in the diagenetic process of *secondary enlargement* 2 A deposit of one mineral growing in oriented crystallographic directions on the surface of another mineral, e.g. hematite on quartz

**overhang** 1 The overhanging part of a cliff 2 A part of the mass of a salt dome that projects out from the top of the dome like the cap of a mushroom

**overlap** 1 The extension of strata beyond the edges of underlying rocks, which are concealed or "overlapped", each younger stratum extends beyond the boundaries of the stratum immediately beneath 2 The area common to two successive aerial photographs or space images along the same flight strip, expressed as a percentage of the photo or image area

**overlay** A record or map on a

transparent medium which may be superimposed on another record or map.

**overloaded stream** A stream that is so heavily loaded with sediment that it is forced to deposit a part of its load, e.g. the Platte River in Nebraska

**oversaturated** (o'-ver-sat'-u-rat'-ed) A syn of *silicic*. Cf *undersaturated*, *unsaturated*.

**oversteepening** (o-ver-steep'-en-ing) The erosive process by which an alpine glacier excessively steepens the sides of an inherited preglacial valley

**overstep** n An *overlap* characterized by the regular truncation of older units of a complete sedimentary sequence by one or more later units of the sequence, the progressive burial of truncated edges of underlying strata below an unconformity (esp. when an unconformity is not very obvious but is made evident by detailed mapping) Cf: *onlap* See also *strike-overlap* —v To transgress, e.g. an unconformable stratum that truncates the upturned edges of the underlying older rocks is said to "overstep" each of them in turn

**overthrust** A low-angle *thrust fault* of large scale, with displacement generally measured in kilometers Cf: *underthrust* Syn *overthrust fault*.

**overturn** The circulation, esp. in the fall and spring, of the layers of water in a lake or sea, whereby surface water sinks and mixes with bottom water; it is caused by

changes in density differences due to changes in temperature, and is esp. common wherever lakes are icebound in winter. See also: *turn-over*; *circulation*.

**overturned** Said of a fold, or the limb of a fold, that has tilted beyond the perpendicular. Sequence of strata thus appears reversed. Such a fold may be called an *overfold*.

**ovoid** Ovate or egg-shaped.

**oxbow 1** A closely looping stream meander, having an extreme curvature such that only a neck of land is left between two parts of the stream. 2 The horseshoe-shaped channel of a former meander, left when the stream formed a cutoff across a narrow meander neck. 3 *oxbow lake*.

**oxbow lake** The crescent-shaped, often ephemeral, body of standing water situated in the abandoned channel (oxbow) of a meander after the stream formed a neck cutoff and the ends of the original bend were silted up. Examples are common along the banks of the Mississippi River. Syn. *oxbow*; *horseshoe lake*.

**oxidates** (ox'-i-dates) Sediments composed of the oxides and hydroxides of iron and manganese, crystallized from aqueous solution. Cf. *resistates*; *evaporates*; *reduzates*; *hydrolyzates*.

**oxidation** (ox-i-da'-tion) The process of combining with oxygen; e.g. the oxidation of Zn given ZnO.

**oxide** (ox'-ide) A mineral com-

pound characterized by the linkage of oxygen with one or more metallic elements, such as cuprite, Cu<sub>2</sub>O, rutile, TiO<sub>2</sub>, or spinel, MgAl<sub>2</sub>O<sub>4</sub>. See also: *hydroxide*.

**oxidized zone** (ox'-i-dized) An area of mineral deposits modified by surface water, e.g. sulfides altered to oxides and carbonates. See also: *supergene enrichment*. Cf. *sulfide zone*; *gossan*; *pyrobre*.

**oxidizing flame** (ox'-i-diz-ing) In blowpiping, the outer, almost invisible, and less intense part of the flame, from which oxygen may be added to the compound being tested. Cf. *reducing flame*.

**Oxisol** (Ox'-i-sol) A soil order characterized by mixtures of quartz, kaolin, free oxides and organic matter, lacking clearly marked horizons. Oxisols are deeply weathered soils on stable surfaces in tropical to subtropical regions.

**oxygen-isotope fractionation** (ox-yen-i'-so-to-pe) Fractionation of oxygen isotopes (oxygen-18/oxygen-16) in oxygen-bearing geologic materials, e.g. carbonate shells of marine organisms, which may be used as an indication of the temperature of formation of the materials.

**ozocerite** (o-zo'-ce-rite) A brown to jet black paraffin wax. It occurs in irregular veins, is soluble in chloroform, and has a variable melting point. There are several varieties. Also spelled: *ozokerite*. Syn: *fossil wax*; *native paraffin*.



# P

**Pacific suite** (Pa-cif'-ic) One of two large groups of igneous rocks, characterized by calcic and calc-alkalic rocks. Harker in 1909 divided all Tertiary and Holocene igneous rocks of the world into two main groups, the *Atlantic suite* and the Pacific suite, the latter being so named because of the predominance of calcic and calc-alkalic rocks in the area of the circum-Pacific orogenic belt. Because there is such a wide variation in tectonic environments and associated rock types in the areas of these suites, the terms are now seldom used to indicate kindred rock types. Cf: *Mediterranean suite*. See also: *andesite line*.

**Pacific-type coastline** A coastline that is broadly parallel to the main trend of the land structure, such as mountain ranges; e.g. the coastline of British Columbia. See also: *Atlantic-type coastline*.

**packer** A short expansible-retractable device deliberately set in a cased or uncased well bore to prevent upward or downward fluid movement; generally for temporary use.

**pack ice** Any area of sea ice formed by the jamming or crushing together of pieces of floating ice; the mass covers the sea surface with little or no open water. See also: *drift ice*. Syn: *ice pack*.

**packing** The spacing or density pattern of the mineral grains in a rock. Cf: *fabric*.

**packstone** A sedimentary carbonate rock whose granular material is arranged in a self-supporting framework, yet also contains some matrix of calcareous mud. Cf: *mudstone*; *grainstone*; *wackestone*.

**pahoehoe** (pa-ho'-e-ho'-e) A Hawaiian term for basaltic lava flows typified by a smooth, billowy, or ropy surface. Varieties include corded, elephant-hide, entrail, festooned, filamented, sharkskin, shelly, and slab pahoehoe. Cf: *aa*. Syn: *ropy lava*.

**paint pot** A type of *mud pot* containing colored mud, usually of cream, pink, or reddish tones.

**paired terraces** Stream terraces that face each other at the same elevation from opposite sides of a stream valley and represent remnants of the same floodplain or valley floor. Cf: *unpaired terrace*.

**palaeo-** *paleo-*.

**palagonite** (pa-lag'-o-nite) A yellow or orange isotropic mineraloid formed by hydration and devitrification of basaltic glass. See also: *palagonite tuff*.

**palagonite tuff** An indurated deposit of glassy basaltic ash in which the constituent particles are largely altered to palagonite.

**paleo-** A combining form meaning old or ancient, e.g. *Paleozoic*, *paleoclimate*. Sometimes given as *pale-* before vowels, e.g. *palevent*.

**paleobiology** (pa'-le-o-bi-ol'-o-gy) A branch of paleontology dealing with the study of fossils as organisms rather than as features of historical geology.

**paleobotany** (pa'-le-o-bot'-a-ny)

The study of the plant life of the geologic past.

**Paleocene** (Pa'-le-o-cene)

An epoch of the early Tertiary period, after the Gulfian of the Cretaceous period and before the Eocene; also, the corresponding worldwide series of rocks. It is sometimes considered to be a period, when the Tertiary is designated as an era.

**paleoclimatology** (pa'-le-o-cli'-ma-tol'-o-gy)

The study of climates of the geologic past.

**paleocurrent** (pa'-le-o-cur'-rent)

A current (generally of water) that existed in the geologic past, whose direction is inferred from the sedimentary structures and textures of the rocks formed at that time.

**paleoecology** (pa'-le-o-e-col'-o-gy)

The study of the relationship between ancient organisms and their environment. See also. *ecology*.

**Paleogene** (Pa'-le-o-gene)

An interval of geologic time incorporating the Paleocene, Eocene, and Oligocene of the Tertiary; the earlier Tertiary. When the Tertiary is designated as an era, then the Paleogene, together with the *Neogene*, may be considered to be its two periods. Syn: *Eogene*; *Nummulitic*.

**paleogeographic map** (pa'-le-o-ge'-

(-graph'-ic) A map that shows the reconstructed physical geography at a particular time in the geologic past, including such information as the distribution of land and seas, geomorphology of

the land, depth of the sea, directions of currents in water and air, distribution of bottom sediments, and climatic belts. Cf: *paleotectonic map*.

**paleogeography** (pa'-le-o-ge-og'-

ra-phy) The study of the physical geography of all or a part of the earth's surface at some time in the geologic past.

**paleogeologic map** (pa'-le-o-ge'-o-

log'-ic) A map that shows the areal geology of a land surface at some time in the geologic past; esp. a map of the surface immediately below an unconformity, showing the geology as it existed at the time the surface of unconformity was completed and before the overlapping strata were deposited. Cf: *subcrop map*.

**Paleolithic** (Pa'-le-o-lith'-ic) n.

In archaeology, the time characterized by the appearance of man and man-made implements. The age generally given for the Paleolithic more or less coincides with the Pleistocene. Cf: *Neolithic*. Syn: *Old Stone Age*.—adj Pertaining to the Paleolithic.

**paleolithologic map** (pa'-le-o-lith'-

o-log'-ic) A map showing lithologic variations at some buried horizon or within some restricted zone at a particular time in the geologic past.

**paleomagnetism** (pa'-le-o-mag'-

net-ism) The study of natural remanent magnetization in order to determine the intensity and direction of the earth's magnetic field in the geologic past.

**paleontologic species** A mor-

*phologic species* based on fossil specimens. It may include specimens that would be considered specifically distinct if living individuals could be observed.

**paleontology** (pa'-le-on-toi'-o-gy)

The study of life in past geologic time, based on fossil plants and animals and including phylogeny, their relationships to existing plants, animals, and environments, and the chronology of the earth's history. Cf: *neontology*. See also: *historical geology*.

**paleopalynology** (pa'-le-o-pal'-y-nol'-o-gy) A division of *palynology* concerned with the study of fossil spores and pollen.

**paleosol** (pa'-le-o-sol) A buried soil; a soil of the past

**paleotectonic map** (pa'-le-o-tec-ton'-ic) A map intended to show geologic and tectonic features as they existed at some time in the geologic past, rather than the sum of all the tectonics of the region, as portrayed on a *tectonic map*. It is similar to a *paleogeographic map* but more emphasis is placed on the tectonic features than on the distribution of lands and seas.

**Paleozoic** (Pa'-le-o-zo'-ic) An era of geologic time, from the end of the Precambrian to the beginning of the Mesozoic, or from about 570 to about 225 million years ago. Also, the *erathem* of rocks deposited during the Paleozoic.

**paleozoology** (pa'-le-o-zo-ol'-o-gy)

That branch of paleontology dealing with the study of animals, both invertebrate and vertebrate.

**palimpsest** (pal'-imp-sest) Said of a

structure or texture in a metamorphic rock in which remnants of some pre-existing structure or texture are preserved. Cf: *relict*.

**palingeneisis** (pal-in-gen'-e-sis) 1. Formation of a new magma by the melting of pre-existing magmatic rock in situ Cf: *anatexis*; *neomagma*. 2. Recapitulation, without change, in the young stages of an organism of the characteristics of its ancestors.

**palinspastic map** (pal-in-spas'-tic)

A paleogeographic or paleotectonic map in which the features represented have been restored as nearly as possible to their original geographic positions, before the rocks of the crust were shortened by folding or telescoped by thrusting.

**palisade** (pal-i-sade') A picturesque, extended rock cliff, rising precipitously from the margin of a stream or lake; esp. one consisting of igneous rock with columnar structure, such as the Palisades along the Hudson River of New York and New Jersey. Term is usually used in the plural.

**Palisades disturbance** (Pal-i-sades') A time of orogeny, supposed to have closed the Triassic Period in eastern North America and elsewhere. The concept is dubious and has only local application at most. Named for the Palisades of New York and New Jersey, the edge of a diabase sill intruded at this time.

**pallasite** (pal'-las-ite) *stony-iron meteorite*.

**paludal** (pa-lu'-dal) Pertaining to a

marsh. See also: *palustrine*.

**palustrine** (pa-lus'-trine) Pertaining to material growing or deposited in a marsh or *paludal* environment.

**palygorskite** (pal-y-gor'-skite) A chain-lattice clay mineral,  $(\text{Mg}, \text{Al})_2\text{Si}_4\text{O}_{10}(\text{OH}) \cdot 4\text{H}_2\text{O}$ ; also, a group name for lightweight fibrous clay minerals characterized by distinctive rodlike shapes under the electron microscope. It has valuable bleaching and adsorbent properties. Syn: *attapulgit*.

**palynology** (pal-y-nol'-o-gy) The study of pollen and spores and their dispersal, and their applications in stratigraphy and paleoecology.

**pan** 1. A shallow depression, esp. one containing a lake or pond. 2. *hardpan*. 3. *salt pan*. 4. *ice pan*.

**panfan** *pediplain*.

**Pangaea** (Pan-gae'-a) *Pangea*.

**Pangea** (Pan-gc'-a) A supercontinent that existed from about 300 to about 200 million years ago and included most of the continental crust of the earth. The present continents were derived from it by fragmentation, via an intermediate stage of *Laurasia* on the north and *Gondwana* on the south. Also spelled: *Pangaea*.

**panning** A technique of prospecting for heavy metals, e.g. gold, by washing placer or crushed vein material in a pan. The lighter fractions are washed away, leaving the heavy metals behind in the pan.

**panplain** A very broad plain formed by the coalescence of sev-

eral adjacent flood plains, each resulting from long-continued lateral erosion by meandering streams; it represents the end stage of an erosion cycle. Cf: *peneplain*. Syn: *panplane*.

**panplane** *panplain*.

**Panthalassa** (Pan-tha-las'-sa) The ocean that surrounded *Pangaea* before its fragmentation.

**pantograph** (pan'-to-graph) An instrument for copying a map or drawing on any predetermined scale of reduction or enlargement.

**paper shale** A shale that splits into thin laminae suggesting sheets of paper. It is often highly carbonaceous.

**parabolic dune** (par-a-bol'-ic) A dune having, in ground plan, approximately the form of a parabola, with the concave side toward the wind.

**paraconformity** (par'-a-con-form'-i-ty) An obscure or uncertain *unconformity* in which no erosion surface is discernible or in which the contact is a simple bedding plane, and in which the beds above and below the break are parallel.

**paraffin-base crude** (par'-af-fin-base) Crude oil that will yield large quantities of paraffin in the process of distillation. Cf: *asphaltic-base crude*; *mixed-base crude*.

**paraffin hydrocarbon** Any of the hydrocarbons of the *paraffin series*.

**paraffin series** A homologous series of open-chain saturated hydrocarbons of the general formula  $\text{C}_n\text{H}_{2n+2}$  of which methane ( $\text{CH}_4$ )

is the first member and the type. Syn: *methane series*.

**paragenesis** (par'-a-gen'-o-sis) A characteristic association or occurrence of minerals or mineral assemblages in ore deposits, connoting contemporaneous formation. Cf: *paragenetic sequence*.

**paragenetic sequence** The sequential order of mineral deposition, as individual phases or assemblages, in an ore deposit. Cf: *paragenesis*.

**parageosyncline** (par'-a-ge'-o-syn'-cline) 1. A geosyncline within a craton or stable area; an epirogenic basin rather than an orogenic belt. Syn: *intraeosyncline*. 2. A contemporary oceanic depression marginal to the craton. Cf: *exogeosyncline*; *idiogeosyncline*.

**parallageosyncline** (pa'-ral'-i-a-ge'-o-syn'-cline) A geosyncline developing along a present-day continental margin, e.g. the Gulf Coast geosyncline.

**paralic** (pa'-ral'-ic) 1. By the sea, but nonmarine; e.g. lagoonal or littoral. Esp. said of intertongued marine and continental deposits laid down on the landward side of a coast or in shallow water subject to marine invasion. 2. Said of coal deposits formed along the margin of the sea, as opposed to *limnic* deposits.

**parallel** (par'-al'-el) 1. One of the imaginary circles on the surface of the earth, parallel to the equator and connecting all points of equal *latitude*; an east-west line of constant latitude. 2. A line, corresponding to a parallel, drawn on

a globe, map, or chart.—Cf: *meridian*.

**parallel drainage pattern** A pattern in which streams and their tributaries are regularly spaced and flow parallel or subparallel to one another over a considerable area. It is indicative of a region having a uniform slope and homogeneous lithology and rock structure.

**parallel evolution** The development of similar forms by related but distinct phylogenetic lineages. See also: *parallelism*; *convergent evolution*.

**parallel extinction** A type of optical extinction in anisotropic crystals parallel to crystal outlines or traces of cleavage planes. Cf: *inclined extinction*; *undulatory extinction*.

**parallel fold** A fold in which the thickness of the layers is constant. Syn: *concentric fold*.

**parallelism** The development of similar characteristics by two or more related organisms in separate lineages, often as a result of similar environmental conditions acting upon similar heredities derived from a long-distant common ancestor. See also: *parallel evolution*; *convergence*.

**paramagnetic** (par'-a-mag-net'-ic) Having a small positive magnetic susceptibility. A paramagnetic mineral such as olivine, pyroxene, or biotite contains magnetic ions that tend to align along an applied magnetic field but do not have a spontaneous magnetic order. Cf: *diamagnetic*.

**parameter** (pa-ram'-e-ter) 1. Any of the axial lengths or interaxial angles that define a unit cell 2. On a crystal face, the rational multiple of the axial length intercepted by a plane, which determines the position of the plane relative to the crystal lattice. 3. In statistics, a number describing a population, also, a constant or variable in a mathematical expression 4. Any of a set of physical properties whose values determine the characteristics or behavior of a system

**paramorph** (par'-a-morph) A pseudomorph with the same composition as the original crystal, as calcite after aragonite.

**paratype** (par'-a-type) Any of the specimens, other than the *holotype*, on which the original description of a species or subspecies is based

**parental magma** (pa-ren'-tal) The magma from which a particular igneous rock solidified or from which another magma was derived. It is sometimes used as a syn. of *primary magma*.

**parent element** The radioactive element from which a daughter element is produced by radioactive decay; e.g. radium is the parent element of radon

**parent material** The unconsolidated material, mineral or organic, from which the *solum* develops. See also: *parent rock*; *residual material*; *transported soil material*.

**park** 1. A term used in the Rocky Mountain region of Colorado and

Wyoming for a wide, grassy open valley lying at a high altitude and walled in by wooded mountains; e.g. South Park in central Colorado 2. A large, grassy area surrounded by woodland, or interrupted by scattered clumps of trees and shrubby vegetation; e.g. a tropical grassland in Africa.

**particle** (par'-ti-cle) A general term, used without restriction as to shape, composition, or internal structure, for a separable or distinct unit in a rock; e.g. a fragment or grain. It usually consists of a mineral.

**particle shape** The geometric form of the particles in a sediment or rock; a fundamental property that determines the relation between mass and surface area. It depends on the *sphericity* and *roundness* of the particle.

**particle size** The general dimensions, such as average diameter or volume, of the particles in a sediment or rock, or of the grains of a particular mineral that make up a sediment or rock, based on the premise that the particles are spheres or that the measurements made can be expressed as diameters of equivalent spheres. It is commonly measured by sieving, by calculating settling velocities, or by determining areas of microscopic images.

**particle-size distribution** The percentage, usually by weight, of particles in each size fraction into which a disaggregated sample of a soil, sediment, or rock has been classified, such as the percentage

of sand retained on each sieve in a given size range.

**particle velocity** The velocity with which an individual particle of a medium moves under the influence of wave motion. Cf: *group velocity*; *phase velocity*.

**parting** 1. The breaking of a mineral along planes of weakness that are not true cleavage, e.g. in garnet. 2. A layer of waste material between veins or beds of ore. 3. A very thin sedimentary layer forming a surface of separation between thicker strata of different lithology, e.g. a *shale break* in sandstone. 4. A plane or surface along which a rock readily separates.

**parafacies** (par-va-fa'-cies) The portion of any *magnafacies* that lies between designated time-stratigraphic planes or key beds traced across the magnafacies.

**pass** 1. A natural passageway through high, difficult terrain, as between two peaks. Cf. *col*. 2. A channel through which a distributary on a delta flows to the sea; specif. a navigable channel on the Mississippi River delta. 3. A navigable channel connecting a body of water with the sea, e.g. through a coastal obstruction such as a barrier reef.

**patch reef** 1. A moundlike or flat-topped *organic reef*, generally less than a kilometer across, frequently forming a part of a larger reef complex. 2. A small, thick, generally unbedded lens of limestone or dolomite, more or less isolated and surrounded by rocks

of unlike facies.—Cf: *reef patch*.

**paternoster lake** (pa'-ter-noe-ter) One of a linear series of small lakes occupying depressions in a glacial valley, connected by streams, rapids, or waterfalls.

**path** 1. The path along which light waves travel through the optical system of a microscop. 2. *raypath*.

**patina** (pat'-i-na) 1. A colored film or thin layer produced on the surface of a rock by weathering. 2. The greenish film formed on copper and bronze after long exposure to a moist atmosphere, consisting of a basic carbonate.—Etymol: Italian

**patterned ground** A group term for the more or less symmetrical forms such as circles, polygons, nets, steps, and stripes that are characteristic of, but not necessarily confined to, surficial material subject to intensive frost action.

**pavement** A closely packed, smooth natural bare-rock surface that resembles a paved road; e.g. *desert pavement*.

**pay** adj. Said of a structure or stratum that contains a mineral deposit (pay gravel, pay streak) or oil and gas (pay sand); also, said of a mineral deposit or part of it that is especially profitable, e.g. pay ore. u A reservoir rock containing oil or gas.—The term is colloquial.

**pay streak** That portion of a vein which carries the profitable ore.

**pay zone** The vertical interval(s) of the stratigraphic section in an oil

or gas field that will yield oil or gas in economic quantities

**peacock copper** *peacock ore*

**peacock ore** Informal name for an iridescent copper mineral having a lustrous, tarnished surface exhibiting variegated colors, such as chalcopyrite and esp. bornite

Syn *peacock copper*

**peak-zone acme zone**

**peat** An unconsolidated deposit of semicarbonized plant remains in a water-saturated environment such as a bog, of persistently high moisture content (at least 75%) It is considered an early stage or rank in the development of coal Carbon content is about 60% and oxygen content is about 30% (moisture free) Structures of the vegetable matter can be seen When dried, peat burns freely

**peat formation** The decomposition of vegetable matter in stagnant water with small amounts of oxygen

**peat-to anthracite theory** A theory of coal formation as a process in which the progressive ranks of coal are indicative of the degree of coalification and, by inference, of relative geologic age Peat, as the initial stage, is of recent geologic age, lignite, as an intermediate stage, is usually Tertiary or Mesozoic, and bituminous coal and anthracite, as the more advanced stages of coalification, are usually Carboniferous

**pebble** A rock fragment, generally rounded by abrasion, larger than a granule and smaller than a cobble, it has a diameter in the range

of 4 to 64 mm, or a size between that of a pea and that of a tennis ball

**pebble armor** A *desert pavement* consisting of rounded pebbles

**pebble dike** 1 A *clastic dike* composed largely of pebbles 2 A tabular body containing sedimentary fragments in an igneous matrix e.g. one whose fragments were broken from underlying rocks by fluids of magmatic origin and injected upward into country rock, becoming rounded due to the milling and/or corrosive action of the hydrothermal fluid.

**pebble phosphate** A secondary phosphorite of either residual or transported origin consisting of pellets, pebbles and nodules of phosphatic material mixed with sand and clay, as in Florida e.g. *land pebble phosphate*

**pedalfer** (pe-dal'-fer) An old general term for a soil characterized by a concentration of sesquioxides It is the typical soil of a humid region Cf *pedocal*

**pedestal boulder** (ped'-es-tal) *pedestal rock*

**pedestal rock** 1 An isolated mass of rock resting on a smaller base or pedestal Syn *pedestal boulder* 2 *perched boulder*

**pediment** (ped'-i-ment) A broad gently sloping erosion surface or plain of low relief, typically developed by running water, in an arid or semiarid region at the base of an abrupt and receding mountain front, it is underlain by bedrock that may be bare but is more often mantled with a thin discontinu-



ous veneer of alluvium derived from the upland masses and in transit across the surface. Cf: *bajada*. Syn: *rock pediment*. See also: *pediplain*.

**pediment pass** A narrow, flat, rock-floored depression connecting pediment slopes on opposite sides of a mountain ridge.

**pedion** (ped'-i-on) A crystal form with only one face

**pediplain** (ped'-i-plain) An extensive thinly alluviated erosion surface formed in a desert region by the coalescence of two or more adjacent pediments and occasional desert domes, and representing the end result of the mature stage of the arid erosion cycle Cf. *pediplane*. Syn: *panfan*.

**pediplane** (ped'-i-plane) 1. Any planate erosion surface, such as a pediment, produced in the piedmont area of an arid or semiarid region 2 A term sometimes used as a syn. of *pediplain*.

**pedocal** (ped'-o-cal) An old, general term for a soil in which there is an accumulation or concentration of carbonates, usually calcium carbonate. It is the characteristic type of soil in an arid or semiarid region. Cf: *pedalfer*.

**pedogenesis** (ped-o-gen'-e-sis) Soil formation.

**pedology** (pe-dol'-o-gy) The study of the morphology, origin, and classification of soils.

**peel-off time** In seismic prospecting, the time correction to be applied to observed data to adjust them to a depressed reference datum.

**peel thrust** A sheet peeled off a sedimentary sequence, essentially along a bedding plane. A series of peel thrusts may be imbricated above a décollement.

**pegmatite** (peg'-ma-tite) An exceptionally coarse-grained igneous rock, with interlocking crystals, usually found as irregular dikes, lenses, or veins, esp. at the margins of batholiths. Most grains are one cm or more in diameter. The composition of pegmatites is generally that of *granite*; it may be simple or complex, and may include rare minerals rich in such elements as lithium, boron, fluorine, niobium, tantalum, uranium, and rare earths. Pegmatites represent the last and most hydrous portion of a magma to crystallize and hence contain high concentrations of minerals present only in trace amounts in granitic rocks Adj *pegmatitic*.

**pegmatitic stage** (peg-ma-tit'-ic) A stage in the normal sequence of crystallization of a magma containing volatiles, at which time the residual fluid is sufficiently enriched in volatile materials to permit the formation of coarse-grained rocks (i.e. pegmatites). The relative amounts of silicate and volatile materials in the fluid, the temperature range, and the relationship of these fluids to hydrothermal fluids are in dispute. Cf: *hydrothermal stage*.

**pelagic** (pe-lag'-ic) 1. Pertaining to the water of the ocean as an environment. See: *epipelagic*; *mesopelagic*. 2. Said of marine organisms

of the open ocean, either *nektonic* or *planktonic*. 3. Pertaining to the deeper part of a lake (10 m or more), characterized by a mud bottom and an absence of aquatic vegetation.

**pelagic deposit** Marine sediment in which the fraction derived from the continents indicates deposition from a dilute mineral suspension distributed throughout deep-ocean water. Cf: *terrigenous deposit*; *hemipelagic deposit*.

**Peléan-type eruption** (Pe-lé-an-type) A type of volcanic eruption characterized by gaseous clouds (*nuées ardentes*) and the development of volcanic domes. Cf: *Hawaiian-type eruption*; *Strombolian-type eruption*; *Vulcanian-type eruption*.

**pelecypod** (pe-lec'-y-pod) Any benthic aquatic mollusk belonging to the class Pelecypoda, characterized by a bilaterally symmetrical bivalve shell, a hatchet-shaped foot, and sheetlike gills. Syn: *lamellibranch*. Partial syn: *bivalve*. Range, Ordovician to present.

**Pele's hair** A natural spun glass formed by blowing-out during quiet fountaining of fluid lava, cascading lava falls, or turbulent flows, sometimes in association with *Pele's tears*. A single strand, with a diameter of less than half a millimeter, may be as long as two meters. Etymol: Pele, Hawaiian goddess of fire.

**Pele's tears** Small solidified drops of volcanic glass behind which trail pendants of *Pele's hair*.

**pelite** (pe'-lite) 1. A mudstone or lutite. 2. The metamorphic derivative of lutite.—Etymol: Greek *pelos*, "clay mud". See also: *psammite*; *psephite*.

**pelitic** (pe-lit'-ic) Pertaining to or derived from pelite; esp. said of a sedimentary rock composed of clay, such as a "pelitic tuff", or a metamorphic rock derived from a pelite, e.g. a "pelitic schist". Cf: *argillaceous*; *lutaceous*.

**pelitomorphic** (pe-lit'-o-mor'-phic) Pertaining to clay-size carbonate particles in a limestone or dolomite. Also, said of a limestone or dolomite consisting of an aggregate of pelitomorphic particles or having a matrix of such particles.

**pellet** A small rounded aggregate of sedimentary material, such as a *fecal pellet*. It is typically made up of clay-sized calcareous material, devoid of internal structure, and is contained in a well-sorted phosphatic or carbonate rock.

**pellicular water** (pel-lic'-u-lar) Water in layers more than one or two molecules thick that adheres to the surfaces of soil and rock particles in the zone of aeration.

**pelmatozoan** (pel'-ma-to-zo'-an) n. Any echinoderm, with or without a stem, that lives attached to a substrate.—adj. Said of an echinoderm having an attached mode of life.

**pelmicrite** (pel-mic'-rite) A limestone consisting of a variable proportion of pellets and carbonate mud (micrite); specif. a limestone containing less than 25% intra-

clasts and less than 25% oöliths, with a volume ratio of pellets to fossils and fossil fragments greater than 3 to 1, and the carbonate-mud matrix more abundant than the sparry-calcite cement.

**pelsparite** (pel-spar'-ite) A limestone consisting of a variable proportion of pellets and clear calcite (spar); specif. a limestone containing less than 25% intracasts and less than 25% oöliths, with a volume ratio of pellets to fossils and fossil fragments greater than 3 to 1, and the sparry-calcite cement more abundant than the carbonate-mud matrix (micrite).

**pendant** (pen'-dant) 1. *roof pendant*. 2 One of a closely spaced group of solutional remnants hanging from the ceiling of a cave.

**penecontemporaneous** (pe'-ne-con-tem'-po-ra'-ne-ous) Formed at almost the same time; e.g. said of a structure or mineral that was formed immediately after deposition of a sediment but before its consolidation into rock.

**peneplain** (pe'-ne-plain) A low, nearly featureless, gently undulating land surface of considerable area, which presumably has been produced by the processes of long-continued mass-wasting, sheetwash, and stream erosion almost to base level in the penultimate stage of a humid, fluvial geomorphic cycle; also, such a surface uplifted to form a plateau and subjected to dissection. Etymol: Latin *pene*, "almost", + *plain*. Syn: *peneplane*.

**peneplanation** (pe'-ne-pla-na'-tion)

The subaerial degradation of a region approximately to base level, forming a peneplain.

**peneplane** (pe'-ne-plane) *peneplain*.

**penehaline** (pe-ne-sa'-line) Said of an environment intermediate between normal marine and *hyperhaline*, characterized by evaporitic carbonates often interbedded with gypsum or anhydrite.

**penetration twin** (pen-e-tra'-tion) A twinned crystal in which the individuals appear to have grown through one another.

**penetrometer** (pen-e-trom'-e-ter) A weight-driven rod for measuring the vertical resistance of snow, soil, or other materials to penetration.

**peninsula** (pe-nin'-su-la) A body of land nearly surrounded by water, and connected with a larger body by a neck or isthmus; also, any tract of land jutting out into the water.

**Pennsylvanian** (Penn-syl-va'-ni-an) A period of the Paleozoic era (after the Mississippian and before the Permian), thought to have covered the span of time between 320 and 280 million years ago; also, the corresponding system of rocks. It is named after the state of Pennsylvania in which rocks of this age are widespread. It is the approximate equivalent of the *Upper Carboniferous* of European usage.

**Penokean orogeny** (Pe-no'-ke-an) A time of deformation and granite emplacement during the Precambrian in Minnesota and

Michigan, dated radiometrically at about 1700 m.y. ago.

**pentagonal dodecahedron** (pen-tag'-o-nal) *pyritohedron*.

**pentane** Any of three paraffin hydrocarbons, formula  $C_5H_{12}$ , found in petroleum and natural gas.

**pentlandite** (pent'-land-ite) A pale bronze isometric mineral,  $(Fe, Ni)_5S_8$ , commonly intergrown with pyrrhotite. Pentlandite is the principal ore of nickel.

**peralkaline** (per-al'-ka-line) In the Shand classification of igneous rocks, a division embracing those rocks in which the molecular proportion of alumina is less than that of sodium and potassium oxides combined Cf: *peraluminous*; *metaluminous*; *subaluminous*.

**peraluminous** (per-a-lu'-mi-nous) In the Shand classification of igneous rocks, a division embracing those rocks in which the molecular proportion of alumina exceeds that of sodium and potassium oxides combined Cf: *peralkaline*; *metaluminous*; *subaluminous*.

**percentage log** (per-cent'-age) A *sample log* in which the percentage of each type of rock present in each sample of well cuttings is estimated and plotted. Cf: *interpretive log*.

**perched boulder** A large erratic lying in an unstable position on a hillside.

**perched ground water** Unconfined ground water separated from the underlying main body of ground water by unsaturated rock.

**perched water table** The upper surface of a body of perched ground water.

**percolation** (per-co-la'-tion) Slow laminar movement of water through small openings within a porous material. Also used as a syn. of *infiltration*.

**percussion mark** (per-cus'-sion) A crescentic scar produced on a hard, dense pebble (esp. of chert or quartzite) by a sharp blow, as by the violent impact of one pebble on another; it may be indicative of high-velocity flow.

**perennially frozen ground** (per-en'-ni-al-ly) *permafrost*.

**perennial stream** (pe-ren'-ni-al) A stream that flows throughout the year; a permanent stream.

**perforation** (per-fo-ra'-tion) Puncturing of well casing opposite an oil- or gas-bearing zone to permit oil or gas to flow into a cased borehole.

**pergelation** (per-ge-la'-tion) The formation of permanently frozen ground in the present or in the past.

**pergellisol** (per-gel'-i-sol) *permafrost*.

**pert-** A prefix meaning "around", "near".

**periclinal** (per-i-cli'-nal) Dipping radially outward from a central point or apex to form a dome, or inward to form a basin. Cf: *quaquaversal*.

**pericline** (per'-i-cine) 1. A British term for a periclinal fold, i.e. a structural dome or a structural basin. 2. A variety of the mineral *albite*.

**peridot** (per'-i-dot) The gem variety of olivine and the birthstone for August.

**peridotite** (pe-rid'-o-tite) A coarse-grained plutonic rock composed chiefly of olivine, with or without other mafic minerals such as pyroxenes, amphiboles, or micas, and containing little or no feldspar. Peridotite is commonly altered to *serpentinite*. See also *dunite*.

**periglacial** (per-i-gla'-cial) 1. Said of the processes, conditions, areas, climates, and topographic features at the immediate margins of glaciers and ice sheets, and influenced by the cold temperature of the ice. 2. By extension, said of an environment in which frost action is an important factor, or of phenomena induced by a periglacial climate beyond the periphery of the ice.

**period** (pe'-ri-od) 1. A geologic time unit longer than an epoch and shorter than an era, during which the rocks of the corresponding *system* were formed. It is the fundamental unit of the geologic time scale. 2. A term used informally for an interval of geologic time, as a "glacial period". 3. The interval of time required for the completion of a cyclic motion or recurring event, e.g. the time between two consecutive like phases of the tide.

**peripheral fault** (pe-nph'-e-ral) An arcuate fault bounding an elevated or depressed area such as a diapir.

**perlite** (per'-lite) 1. A volcanic

glass having the composition of rhyolite, a *perlitic structure*, and a generally higher water content than obsidian. 2. In commercial usage, a volcanic glass that will expand or "pop" when heated to form a *lightweight aggregate*.

**perlitic structure** (per-lit'-ic) A feature of glassy igneous rocks that have cracked due to contraction during cooling, the cracks forming small concentric pearl-like spheroids.

**permafrost** (per'-ma-frost) Permanently frozen soil or subsoil, occurring in arctic, subarctic, and alpine regions. Its thickness ranges from 30 cm to over 1000 m, it underlies about one-fifth of the earth's land area. Syn: *perennially frozen ground*; *permanently frozen ground*; *pergelisol*.

**permafrost table** The upper limit of permafrost, represented by an irregular surface dependent on local factors. Cf: *frost line*.

**permanently frozen ground** (per'-ma-nent-ly) *permafrost*.

**permeability** (per'-me-a-bil'-i-ty)

1. The capacity of a porous rock, sediment, or soil for transmitting a fluid, it is a measure of the relative ease of fluid flow under unequal pressure. The customary unit of measurement is the *millidarcy*. Cf: *absolute permeability*; *effective permeability*; *relative permeability*. Adj: *permeable*. 2. The ratio of magnetic induction *B* to inducing field strength *H*.

**permeability coefficient** The rate of flow of water in gallons per day through a cross section of one

square foot under a unit hydraulic gradient, at the prevailing temperature or adjusted for a temperature of 60°F. Cf: *capillary conductivity*. Syn: *hydraulic conductivity*; *Meinzer unit*.

**permeability trap** A trap for oil or gas formed by lateral variation of permeability within a reservoir bed.

**permeable** (per'-me-a-ble) Said of a rock or sediment that allows water, oil, or gas to move through it at an appreciable rate via supercapillary openings. Syn: *pervious*. Ant: *impermeable*.

**Permian** (Per'-mi-an) The last period of the Paleozoic era (after the Pennsylvanian), thought to have covered the span of time between 280 and 225 million years ago, also, the corresponding system of rocks. The Permian is sometimes considered part of the Carboniferous, or is divided between the Carboniferous and Triassic. It is named after the province of Perm, USSR, where rocks of this age were first studied. See also: *age of amphibians*.

**permineralization** (per'-min-er-a'-i-za'-tion) The process of fossilization wherein the original hard parts of an animal have additional mineral material deposited in their pore spaces.

**permissive intrusion** (per-mis'-sive) Emplacement of magma in spaces created by forces other than its own, e.g. orogenic forces; also, the magma or rock body so emplaced. Cf: *forcible intrusion*.

**Permo-Carboniferous** (Per'-mo-

Car'-bon-if'-er-ous) Strata not differentiated between the Permian and Carboniferous systems, particularly in regions where there is no conspicuous stratigraphic break and fossils are transitional.

**Permo-Triassic** (Per'-mo-Tri-as'-sic) Said of strata not differentiated between the Permian and Triassic systems, particularly in regions where the boundary occurs within a nonmarine red-beds succession.

**perpendicular slip** (per-pen-dic'-u-lar) The component of the slip of a fault that is measured perpendicular to the trace of the fault on any intersecting surface.

**perpendicular throw** In a faulted bed, vein, or other planar feature, the distance between two formerly adjacent points, measured perpendicular to the surface.

**Perret phase** (Per-ret') That stage of a volcanic eruption characterized by the emission of much high-energy gas that may significantly enlarge the volcanic conduit.

**perthite** (perth'-ite) A variety of alkali feldspar consisting of intergrowths in which the potassium-rich phase (usually microcline) appears to be the host from which the sodium-rich phase (usually albite) exsolved. The exsolved areas typically form strings, lamellae, blebs, films, or irregular veinlets.

Cf: *antiperthite*.

**pervious** (per'-vi-ous) *permeable*.

**Potoskey stone** (Pe-tos'-key) A waterworn fragment of Devonian

colonial coral from the beach of Lake Michigan at Petoskey, Mich. It is the "state rock" of Michigan.

**petrification** (pet-ri-fac'-tion) A process of fossilization whereby organic matter is converted into a stony substance by the infiltration of water containing dissolved inorganic matter (e.g. calcium carbonate, silica) which replaces the original organic materials, sometimes retaining the structure.

**petrified rose** (pet'-ri-fied) *barite rosette*.

**petrified wood** *silicified wood*.

**petro-** A prefix meaning "rock".

**petrochemistry** (pet-ro-chem'-istry) The study of the chemical composition of rocks; it is an aspect of geochemistry, and is not equivalent to petroleum chemistry.

**petrofabric analysis** (pet-ro-fab'-ric) *structural petrology*.

**petrofabric diagram** *fabric diagram*.

**petrofabrics** *structural petrology*.

**petrofacies** (pet-ro-fa'-cies) *petrographic facies*.

**petrogenesis** (pet-ro-gen'-e-sis) A branch of petrology that deals with the origin and formation of rocks, esp. of igneous rocks.

**petroglyph** (pet'-ro-glyph) Literally, a rock carving; it usually excludes writing and therefore is of prehistoric or protohistoric age.

**petrographer** (pe-trog'-ra-pher) One versed in the science of petrography.

**petrographic facies** (pet-ro-graph'-ic) Facies distinguished primarily

on the basis of appearance or composition, without respect to form, boundaries, or mutual relations. They consist of large bodies of rock occurring in certain areas and in more or less restricted parts of the stratigraphic section, e.g. "red-bed facies", "geosynclinal facies"; or they may consist of all rocks of a single kind, e.g. "black-shale facies", "graywacke facies". See also: *facies*. Cf: *stratigraphic facies*. Syn: *petrofacies*.

**petrographic microscope** *polarizing microscope*.

**petrographic period** The time represented by a rock association. Cf: *petrographic province*.

**petrographic province** A broad area in which some or all of the igneous rocks are considered to have been formed during the same period of magmatic activity. Cf: *petrographic period*. See also: *comagmatic*.

**petrography** (pe-trog'-ra-phy)

That branch of geology dealing with the description and systematic classification of rocks, esp. igneous and metamorphic rocks and esp. by means of microscopic examination of thin sections. Petrography is more restricted in scope than *petrology*.

Adj: *petrographic*

**petroleum** (pe-tro'-le-um) 1. A naturally occurring complex liquid hydrocarbon, which after distillation and removal of impurities yields a range of combustible fuels, petrochemicals, and lubricants. Syn: *crude oil*. 2. A general term for all naturally occurring

hydrocarbons, whether gaseous, liquid, or solid.

**petroleum geologist** A geologist engaged in exploration for, or production of, oil or gas. See also: *petroleum geology*.

**petroleum geology** The branch of economic geology that relates to the origin, migration, and accumulation of oil and gas, and to the discovery of commercial deposits. Its practice involves the application of geochemistry, geophysics, paleontology, structural geology, and stratigraphy to the problems of finding hydrocarbons. See also *petroleum geologist*.

**petroliferous** Containing or yielding petroleum.

**petrologist** (pe-trol'-o-gist) One who is engaged in the study of petrology.

**petrology** (pe-trol'-o-gy) That branch of geology dealing with the origin, occurrence, structure, and history of rocks, esp. igneous and metamorphic rocks. Petrology is broader in scope than *petrography*. Adj. *petrologic*. See also: *sedimentary petrology*.

**pH** The negative  $\log_{10}$  of the hydrogen-ion activity in solution; a measure of the acidity or basicity of a solution.

**phacolith** (phac'-c-lith) A minor concordant intrusive in the crest of an anticline or the trough of a syncline; it is concavo-convex in cross section. Cf. *harpolith*.

**phanerite** (phan'-er-ite) An igneous rock having the grains of its essential minerals large enough to

be seen macroscopically.

**phaneritic** (phan-er-it'-ic) Said of the texture of an igneous rock in which the individual components are distinguishable with the unaided eye, i.e. megascopically crystalline. Also, said of a rock having such texture. Cf. *aphanitic*. Syn: *coarse-grained*.

**Phanerozoic** (Phan'-er-o-zo'-ic) That part of geologic time represented by rocks in which the evidence of life is abundant, i.e. Cambrian and later time. Cf. *Cryptozoic*.

**phantom crystal** (phan'-tom) A crystal within which an earlier stage of crystallization or growth is outlined by dust, tiny inclusions, or bubbles, e.g. serpentine containing a ghost or phantom of original olivine.

**phase** 1 A homogeneous, physically distinct portion of matter. 2. An informal subdivision of a glacial stage. 3. An interval in the development of a process, esp. in the igneous activity of a region, e.g. a "volcanic phase". 4. A transitory or minor fluctuation in the velocity of a depositing current, resulting in the formation of a *lamina*; also, the lamina itself. 5. A term that has been widely and vaguely used in stratigraphy—for facies, a part of a cyclothem, a time-stratigraphic division, etc.—and is best left without restriction as to special meaning in this field.

**phase diagram** A graph designed to show the boundaries of the fields of stability of the various phases of a system. The coordi-



nates are usually two or more of the intensive variables temperature, pressure, and composition, but are not restricted to these.

**phase equilibria** In physical chemistry, the study of those phases which, under specified conditions, may exist in equilibrium.

**phase rule** The statement that for any system in equilibrium, the number of *degrees of freedom* is two greater than the difference between the number of components and the number of phases. It may be symbolically stated as  $F = (C - P) + 2$ . See also: *Goldschmidt's phase rule*.

**phase velocity** The velocity with which an observable, individual wave or wave crest is propagated through a medium; the velocity of a point of constant phase. It is the product of wavelength and frequency. Cf: *group velocity*; *particle velocity*.

**phenocryst** (phe'-no-cryst) One of the relatively large and ordinarily conspicuous crystals of the earliest generation in a porphyritic igneous rock.

**phi grade scale** A logarithmic transformation of the *Wentworth grade scale* in which the negative logarithm to the base 2 of the particle diameter (in millimeters) is substituted for the diameter value; it has integers for the class limits, increasing from -5 for 32 mm to +10 for 1/1024 mm. The scale was developed specifically as a statistical device to permit the direct application of conventional statistical practices to sedimen-

tary data.

**phlogopite** (phlog'-o-pite) A magnesium-rich mineral of the mica group:  $K(Mg, Fe)_3AlSi_3O_{10}(OH, F)_2$ . It is yellowish brown to brownish red and usually occurs in crystalline limestones as a result of dedolomitization.

**phonolite** (pho'-no-lite) 1. In the strictest sense, a group of fine-grained extrusive rocks primarily composed of alkali feldspar (esp. anorthoclase or sanidine), and with nepheline as the main feldspathoid; also, any rock in that group; the extrusive equivalent of *nepheline syenite*. 2. In the broadest sense, any extrusive rock composed of alkali feldspar, mafic minerals and any feldspathoid, such as nepheline, leucite, or sodalite. Etymol: Greek *phone*, "sound", in reference to the allegedly characteristic ringing sound emitted by a phonolite when struck with a hammer.

**phorogenesis** (phor-o-gen'-e-sis) Slipping of the earth's crust over the mantle.

**phosphate** (phos'-phate) A mineral compound containing tetrahedral  $PO_4^{-3}$  groups. An example is pyromorphite,  $Pb_5(PO_4)_3Cl$ . Phosphorus, arsenic, and vanadium may substitute for each other in the tetrahedron. Cf: *arsenate*; *vanadate*.

**phosphate rock** Any rock that contains one or more phosphatic minerals, esp. apatite, of sufficient purity and quantity to permit its commercial use as a source of phosphatic compounds or ele-

mental phosphorus. About 90% of the world's production is sedimentary phosphate rock, or *phosphorite*; the remainder is igneous rock rich in apatite.

**phosphatic nodule** (fahs'fah'tik)

A black, gray, or brown rounded mass or "pebble", ranging in diameter from a few millimeters to more than 30 cm, consisting of coprolites, corals, shells, times sand grains, mica flakes, or sponge spicules more or less enveloped in *collophane* (calcium phosphate). They occur in marine strata (as in Permian beds of western U.S. and in the Cretaceous chalk of England), and are forming at present on the sea floor (as off the coast of California).

**phosphorescence** (phos'fho-res-ence) A type of *luminescence* in which the stimulated substance continues to emit light after the external stimulus has ceased, also, the light so produced. The duration of the emission is temperature-dependent, and has a characteristic rate of decay. Cf. *fluorescence*.

**phosphorite** (fahs'fho-nite) A sedimentary rock with a high enough content of phosphate minerals to be of economic interest. Most commonly it is a bedded primary or reworked secondary marine rock composed of microcrystalline carbonate fluorapatite in the form of laminae, pellets, oolites, nodules, and skeletal, shell, and bone fragments. See also *bone phosphate of lime*, *pebble sandstone guano*.

**photogeology** (pho'-to-ge-ol'-o-gy)

The geologic interpretation of aerial photographs.

**photogrammetry** (pho-to-gram'me-try) The science and art of obtaining reliable measurements from photographs.

**photomap** An aerial photograph or a *controlled mosaic* to which have been added a reference grid, scale, place names, marginal information, and other pertinent data or map symbols.

**photomicrograph** (pho-to-mi'-cro-graph) A photographic enlargement of a microscopic image such as a petrologic thin section. Less-preferred syn. *microphotograph*.

**phreatic cycle** (phre-at'-ic) The period of time during which the water table rises and then falls. It may be a daily, annual, or other cycle.

**phreatic explosion** A volcanic eruption or explosion of steam, mud, or other material that is not incandescent, it is caused by the heating and consequent expansion of ground water due to an underlying igneous heat source.

**phreatic water** A term that originally was applied only to water that occurs in the upper part of the zone of saturation under water-table conditions (syn. of *unconfined ground water*), but has come to be applied to all water in the zone of saturation, thus making it an exact synonym of *ground water*.

**phreatic zone** zone of saturation

**phyla** Plural of *phylum*

**phyletic** (nhv-let'ic) *phylogenetic*

**phyletic evolution** Evolution involving changes in *lineages* but little or no increase in the number of taxonomic groups

**phylite** (phyl'ite) A metamorphosed rock intermediate in grade between slate and mica schist. Minute crystals of sericite and chlorite impart a silky sheen to the cleavage surfaces which are commonly winkled

**phylosilicate** (phy'los'i-late) A class of silicate type of silicate minerals characterized by the sharing of three of the four oxygens in each tetrahedron with neighboring tetrahedra to form flat sheets. The Si:O ratio is 2:5. An example is the mica. Syn. *sheet mineral*.

**phylogenetic** (phy'lo-ge-net-ik) The study of *phylogeny*. Syn. *phyletic*

**phylogeny** (phy'log-e-ny) 1. The line or line of direct descent in a given group of organisms, as proposed to the development of an individual organism. Cf. *ontogeny*. 2. The study or history of such relationships. Adj. *phylogenetic*

**phylum** (phy'lum) A category in the hierarchy of zoological classification between *kingdom* and *class*. Pl. *phyla*.

**physical geography** (phys'i-cal) That branch of *geography* which is the descriptive study of the earth's surface as man's physical environment

**physical geology** A broad division of *geology* that concerns itself with the processes and forces involved in the formation of

of the earth and morphology and with its constituent minerals, rocks, magmas and core material. Cf. *historical geology*.

**physical oceanography** The study of such physical aspects of the ocean as optical and acoustic properties, temperature, density and currents, waves and tides.

**physical stratigraphy** Stratigraphy based on the physical aspects of rocks (esp. the sedimentologic aspects), e.g. *lithostratigraphy*.

**physiographic cycle** (phys'i-og-raph-ic) *cycle of erosion*

**physiographic province** A region of which all parts are similar in geologic structure and climate and which has had a unified geomorphic history. Its relief features differ significantly from those of adjacent regions. Examples: the Valley and Ridge province in eastern U.S. and the Basin and Range province in western U.S. Cf. *geologic province*, *geographic province*.

**physiography** (phys'i-og-i-a-phy) Originally, a description of the physical nature of objects (esp. of natural features); later it became synonymous with *physical geography*. Still later, esp. in the U.S., the term was restricted to the description and origin of landforms; in this sense it is obsolescent and is replaced by *geomorphology*.

**phyteral** (phy'ter-al) Vegetal matter in coal that is recognizable as morphologic forms, e.g. cuticle, spore coats or wax, as distinguished from the *macerals*.

Cf. *maceral*, *form*.

mass.

**phytolith** (phy'-to-lith) 1. A stony or mineral structure, generally microscopic, secreted by a living plant; often composed of calcium oxalate or opaline silica. 2. A rock formed by plant activity or composed of plant remains.

**phytoplankton** (phy-to-plank'-ton) All floating plants, such as diatoms. Cf: *zooplankton*.

**picrolite** (pic'-ro-lite) A term that has been applied to a fibrous or columnar variety of serpentine mineral. It is now regarded as a syn. of *antigorite*.

**pictograph** (pic'-to-graph) A picture painted on a rock by primitive peoples and used as a sign.

**piecemeal stoping** A process whereby a magma eats into its roof by engulfing relatively small isolated blocks, which presumably sink to a depth where they are assimilated. Cf: *magmatic stoping*; *ring-fracture stoping*.

**piedmont** adj. Lying or formed at the base of a mountain or mountain range; e.g. a piedmont terrace or pediment.--A feature at the base of a mountain; e.g. a foothill or a bajada

**piedmont alluvial plain** *bajada*.

**piedmont glacier** A glacier formed by coalescence of two or more valley glaciers at the base of a mountain range.

**piedmont plateau** A plateau lying between the mountains and the plains or the ocean; e.g. the Piedmont province of the southeastern U.S., lying between the Blue Ridge and the Atlantic Coastal

Plain.

**piercement dome** *diapir*.

**piezoelectric effect** (pi-e'-zo-e-lec'-tric) In certain crystals, the development of an electrical potential in certain crystallographic directions when mechanical strain is applied, or, the development of a mechanical strain, hence vibration, when an electric potential is applied. Quartz and tourmaline are examples of naturally piezoelectric crystals.

**piezometric surface** (pi-e'-zo-met'-ric) *potentiometric surface*.

**pillow lava** A general term for those lavas displaying *pillow structure* and considered to have formed under water; such lava is usually basaltic or andesitic. Syn: *ellipsoidal lava*.

**pillow structure** 1. A structure in certain extrusive igneous rocks that is characterized by discontinuous pillow-shaped masses, commonly between 30 and 60 cm in greatest dimension. It is considered to be a product of subaqueous extrusion. 2. A primary sedimentary structure resembling the size and shape of a pillow; it is most common in the basal parts of a sandstone overlying shale.

**pilotaxitic** (pi'-lo-tax-it'-ic) Said of the texture of the groundmass of a holocrystalline igneous rock in which lath-shaped microlites (typically plagioclase) are interwoven in irregular unoriented fashion. Cf: *trachytic*. Syn: *felty*.  
**pimple mound** A term used along the Gulf Coast of eastern Texas

and SW Louisiana for one of hundreds of thousands of low, rudely circular or elliptical domes composed of sandy loam that is coarser than the surrounding soil; the basal diameter ranges from 3 m to more than 30 m, and the height from 30 cm to more than 2 m. Cf: *Mima mound*.

**pimple plain** A plain characterized by numerous conspicuous pimple mounds.

**pinacoid** (pin'-a-coid) An open crystal form consisting of two parallel faces. Adj: *pinacoidal*.

**pinch** n. A compression of the walls of a vein, or the roof and floor of a coal bed, which more or less completely displaces the ore or coal. Cf: *nip*. See also: *swell*. — v. *pinch out*.

**pinch out** To taper or narrow progressively to extinction; to *thin out*. See also: *pinch-out*.

**pinch-out** The termination or end of a stratum or vein that narrows or thins progressively in a given direction until it disappears and the rocks it once separated are in contact; esp. a *stratigraphic trap* formed by the thinning-out of a porous and permeable sandstone between two layers of impermeable shale. The lithologic character of the stratum is typically maintained to the feather edge.

**pingo** (pin'-go) A large *frost mound* of soil-covered ice, 30-50 m high and up to 400 m in diameter, raised in part by hydrostatic pressure of water within or below the permafrost of Arctic regions (esp. Canada), and of more than

one year's duration. Etymol: Eskimo, "conical hill".

**pinnacle** (pin'-na-cle) 1. A tall, slender pillar of rock; also, a lofty peak. 2. A spire or column of rock or coral, either submerged or awash. Syn: *pinnacle reef*.

**pinnacle reef** 1. *pinnacle*. 2. A term used in the Michigan Basin to apply to an isolated stromatopore-algal reef mound, now dolomitized, in the Middle Silurian rocks of the subsurface; many are productive of oil. They range up to 500 acres in area and 500 feet in relief, with slopes rarely exceeding 15 degrees. They are mounds rather than true pinnacles.

**pinnate drainage pattern** (pin'-nate) A drainage pattern in which the main stream receives many closely spaced, subparallel tributaries that join it at acute angles, resembling in plan a feather; it is believed to indicate unusually steep slopes on which the tributaries developed.

**pioneer** (pi-o-neer') In ecology, a community, species, flora, fauna, or individual that establishes itself in a barren area, initiating a new ecologic cycle or *sere*. Cf: *climax*.

**pipe** 1. The vertical conduit below a volcano, through which the magmatic materials passed. It is usually filled with breccia and may be mineralized. 2. A tubular cavity in calcareous rocks, often filled with sand and gravel, e.g. a vertical joint or sinkhole formed by solution in chalk. 3. A cylin-

dinal more or less vertical ore body 4 A discordant pluton of tubular shape 5 *geyser pipe*

**pipe clay** A white to grayish white highly plastic clay practically free from iron suitable for use in making tobacco pipes. The term has been extended to include any white burning clay of considerable plasticity Syn *bal clay* *petters clay* Also spelled *pipelitz*

**piperno** (pi per no) A welded tuff characterized by *flim structure*. Such a rock is said to be pipernoïd. From Italy

**pipestone** *atlinit*

**piracy** (pi ra cy) The natural diversion of the headwaters of one stream into the channel of another stream having greater erosional activity Syn *capture stream capture*

**pisolite** (pi so lite) 1 A sedimentary rock commonly a limestone made up chiefly of cemented pisoliths a coarse grained *oolite* 2 A term often used for *pisolith* 3 An individual unit in a mass of accretionary *lapilli*

**pisolith** (pi so lith) An accretionary body in a sedimentary rock resembling a pea in size and shape and constituting one of the grains that make up a *pisolite*. It is often formed of calcium carbonate, and some are thought to have been produced by a biochemical algal encrustation process. A pisolith is larger and less regular in form than an *oolith* although it has the same concentric and radial internal structure. The term is sometimes used to refer to

the rock made up of pisoliths

**pisolithic tuff** (pi so-lit-ic) An indurated pyroclastic deposit made up chiefly of accretionary lapilli or pisoliths

**pitch** 1 The angle between the horizontal and any linear feature, e.g. an ore shoot or lineation measured in the plane containing the linear feature Syn *rake* 2 A vertical shift in a cave 3 A steep place or declivity 4 *asphalt*

**pitchblende** A massive brown to black variety of *uraninite* found in hydrothermal sulfide-bearing veins. It is colloform amorphous or microcrystalline and has a distinctive pitchy to dull luster

**pitch length** The length of an ore shoot in its greatest dimension

**pitchstone** A volcanic glass with a waxy dull resinous luster. Its color and composition vary widely but contains a higher percentage of water than *obsidian*. Crystallites are detectable in thin section

**pitted outwash** Outwash with pits or kettles produced by the partial or complete burial of glacial ice by outwash and the subsequent thaw of the ice and collapse of the surficial materials

**pitted plain** A plain underlain by pitted outwash

**pivotal fault** (piv o-tal) *hinge fault*

**placental** (pla-sen-tal) A member of the mammalian subclass *Eutheria* characterized by bearing young in a relatively advanced state of development. Range, Cretaceous to present Cf *marsupial*

**placer** (plac'-er [plas'-ser]) A surficial mineral deposit formed by mechanical concentration of mineral particles from weathered debris. The common types are *beach placers* and *alluvial placers*. The mineral concentrated is usually a heavy mineral such as gold, cassiterite, or rutile. Cf: *lode*. Syn: *lead*, *placer deposit*.

**placer deposit** *placer*.

**placer mining** The extraction and concentration of heavy metals or minerals from placer deposits by various methods, generally using running water. Cf: *hydraulic mining*.

**placoderm** (plac'-o-derm) A member of a class of jawed vertebrates, the Placodermi, characterized by the development of external armor with elaborate head and trunk shields. Range, Early to Late Devonian.

**plagioclase** (pla'-gi-o-clase) 1. A group of triclinic feldspars of general formula  $(\text{Na,Ca})\text{Al}(\text{Si,Al})\text{Si}_2\text{O}_8$ . At high temperatures it forms a complete solid-solution series from Ab ( $\text{NaAlSi}_3\text{O}_8$ ) to An ( $\text{CaAl}_2\text{Si}_2\text{O}_8$ ). The series is subdivided and named according to increasing mole fraction of the An component: albite (An 0-10), oligoclase (An 10-30), andesine (An 30-50), labradorite (An 50-70), bytownite (An 70-90), and anorthite (An 90-100). Plagioclase minerals are among the commonest rock-forming minerals. 2. A mineral of the plagioclase group.

small, at a low elevation, an extensive region of level or gently undulating land. 2. An extensive tract of level or rolling, almost treeless country, a *prairie*. The term is usually used in the plural. — Cf: *plateau*.

**plain of denudation** A surface that has been reduced to or nearly to sea level by the agents of erosion.

**planar cross-bedding** (pla'-nar) 1. Cross-bedding in which the lower bounding surfaces are planar surfaces of erosion; it results from beveling and subsequent deposition. 2. Cross-bedding characterized by planar foreset beds.

**planar element** A fabric element having two dimensions that are much greater than the third. Examples are bedding, cleavage, and schistosity. Cf: *linear element*; *equant element*.

**planar flow structure** *platy flow structure*.

**planation** (pla-na'-tion) 1. The processes of erosion whereby the surface of the earth or any part of it is reduced to a fundamentally flat or level surface, specif. *lateral planation* by a meandering stream. 2. A broad term for the general lowering of the land; e.g. *peneplanation*.

**plane** A two-dimensional form that is without curvature; ideally, a perfectly flat or smooth surface. In geology the term is applied to such features as a *bedding plane*. Adj: *planar*. Cf: *surface*.

**plane correction** A correction applied to observed surveying data

erence plane.

**plane of symmetry** 1. A plane dividing a crystal into halves, one of which is the mirror image of the other. 2. The plane that bisects an organism or its shell symmetrically —Syn: *symmetry plane*.

**plane-polarized light** Light constrained to vibrate in a single plane, as by a Nicol prism.

**plane strain** A state of strain in which all displacements that arise from deformation are parallel to one plane, and the longitudinal strain is zero in one principal direction.

**plane stress** A state of stress in which one of the principal stresses is zero.

**plane surveying** Surveying in which the curvature of the earth is disregarded, as in ordinary field and topographic surveying. Cf. *geodetic surveying*.

**plane table** A simple instrument for plotting the lines of a survey directly from field observations. It consists of a board mounted on a tripod, fitted with an *alidade* or other sighting device. Also spelled *plane table*.

**planetesimal hypothesis** (plan-et-es'i-mal) A concept of the formation of the planets by the accretion of a cloud of small cold bodies, sometimes called "planetesimals."

**planetology** (plan-e-toi'-o-gy) Study of the condensed matter of the solar system, including planets, satellites, asteroids, meteorites, and interplanetary material. The term is frequently used as a

syn. of *astrogeology*.

**planimeter** (pla-nim'-e-ter) An instrument for measuring the area of any plane figure by passing a tracer around the perimeter.

**planimetric map** A map that presents only the relative horizontal positions of natural or cultural features, by lines and symbols. It is distinguished from a topographic map by the omission of relief in measurable form.

**planimetry** (pla-nim'-e-try) The determination of horizontal distances, angles, and areas by measurements on a map.

**plankton** Floating and drifting aquatic organisms. See also: *phytoplankton*; *zooplankton*. Adj. *planktonic*.

**plankton bloom** An aquatic growth of algae or other organisms in such concentrations as to discolor the water. See also: *red tide*.

**planktonic** (plank-ton'-ic) Floating adj. of *plankton*.

**Planosol** (Plan'-o-sol) An intrazonal, hydromorphic group of soils having a leached surface layer above a definite clay pan or hardpan. These soils develop on nearly flat upland surfaces under grass or trees in a humid to sub-humid climate.

**plastic** (plas'-tic) Capable of being deformed permanently without rupture. Cf. *elastic*.

**plastic deformation** A permanent change in shape of a solid that does not involve failure by rupture. Syn: *plastic flow*; *plastic strain*.



**plastic flow** *plastic deformation.*

**plastic limit** The water-content boundary of a sediment, e.g. a soil, between the plastic and semisolid states. It is one of the *Atterberg limits*. Cf. *liquid limit*

**plastic strain** *plastic deformation.*

**plat** A diagram drawn to scale showing all essential data pertaining to the boundaries and subdivisions of a tract of land as determined by survey, together with the data required for accurate identification and description of the various units shown and including one or more certificates indicating due approval

**plate** A torsionally rigid thin segment of the earth's lithosphere, which may be assumed to move horizontally and adjoin other plates along zones of seismic activity. See also *plate tectonics*.

**plateau** (pla-teau') A relatively elevated area of comparatively flat land which is commonly limited on at least one side by an abrupt descent to lower ground, specifies an extensive land area more than 150-300 m above the adjacent country or above sea level. It is higher than a plain and more extensive than a mesa. Cf. *tableland*

**plateau basalt** A term applied to those basaltic lavas that occur as vast composite accumulations of horizontal or subhorizontal flows, which, erupted in rapid succession over great areas, have at times flooded sectors of the earth's surface on a regional scale. They are generally believed to be

the product of *fissure eruptions*. Cf. *shield basalt*. Syn. *flood basalt*

**plateau glacier** An ice sheet that occupies a relatively flat mountainous area. See also *ice plateau*.

**plateau mountain** A mountainous area produced by the dissection of a plateau, e.g. the Catskill Mountains, N.Y.

**plate boundary** Zone of seismic and tectonic activity along the edges of lithosphere plates, presumed to indicate relative motion between them

**plate tectonics** A theory of *global tectonics* in which the lithosphere is divided into a number of *plates* whose pattern of horizontal movement is that of torsionally rigid bodies that interact with one another at their boundaries, causing seismic and tectonic activity along these boundaries

**platform** 1 Any level or nearly level surface, ranging in size from a terrace or bench to a plateau or peneplain. 2 *wave-cut platform*. 3 That part of a continent that is covered by flat lying or gently tilted sedimentary rocks, underlain by a complex of rocks that were consolidated during earlier deformations. The platform is a part of the *craton*. 4 A flat or shelflike structure in various invertebrate fossils

**platy flow structure** An igneous rock structure of tabular sheets, suggesting stratification. It is formed by contraction during cooling, the structure is parallel to the surface of cooling, and is com-

monly accentuated by weathering. Syn. *planar flow structure*.

**playa** (pla'-ya [ply'-ah]) 1 A term used in the southwestern U S for a dry, barren area in the lowest part of an undrained desert basin, underlain by clay, silt, or sand, and commonly by soluble salts. It may be marked by an ephemeral lake. See also *alkali flat*; *dry lake*. 2 *playa lake*. 3 A small sandy land area at the mouth of a stream or along a bay shore — Etymol. Spanish, "beach, strand, coast"

**playa lake** A shallow intermittent lake in an arid region, occupying a playa in the wet season but drying up in summer, an ephemeral lake that upon evaporation leaves or forms a playa. Syn. *playa*.

**Playfair's law** A generalization about the relation of stream systems to their valleys, enunciated by John Playfair in 1802 "Every river appears to consist of a main trunk, fed from a variety of branches, each running in a valley proportioned to its size, and all of them together forming a system of valleys communicating with one another, and having such a nice adjustment of their declivities that none of them join the principal valley either on too high or too low a level a circumstance which would be infinitely improbable if each of these valleys were not the work of the stream which flows in it"

**play of color** An optical phenomenon consisting of flashes of pris-

sion as certain minerals, esp. opal, are moved about, e.g. *opalescence*. It is caused by diffraction of light from innumerable minute regularly arranged particles of amorphous silica, stacked in an orderly three-dimensional pattern that behaves like a diffraction grating.

**Pleistocene** (Pleis'-to-cene) An epoch of the Quaternary period, after the Pliocene of the Tertiary and before the Holocene also, the corresponding worldwide series of rocks. It began two to three million years ago and lasted until the start of the Holocene some 8,000 years ago. When the Quaternary is designated as an era, the Pleistocene is considered to be a period. Syn. *ice age*, *glacial epoch*. **pleochroism** (ple'-o-chro-ism) The ability of an anisotropic crystal to differentially absorb various wavelengths of transmitted light in various crystallographic directions, and thus to show different colors in different directions. This property is best seen under polarized light. A mineral showing pleochroism is said to be *pleochroic*. See also *dichroism*, *trichroism*.

**pleosponge** (ple-o-sponge') *archaeocythid*.

**plication** (pli-ca'-tion) 1 Intense small-scale folding. Adj. *plicated*. Cf. *crenulation*. 2 A coarse radial corrugation in the surface of a bivalve-mollusk or brachiopod shell.

**Plinian eruption** (Plin'-i-an) An

steady turbulent stream of fragmented magma and magmatic gas is released at a high velocity from a vent. Large volumes of pyroclastics and tall eruption columns are characteristic. It was this type of eruption centered approximately on the site of the present-day Vesuvius, that buried the cities of Herculaneum and Pompeii under thick deposits of volcanic debris. Etymoi: Pliny the Younger, A.D. 79.

**Pliocene** (Plī'-o-cene) An epoch of the Tertiary period, after the Miocene and before the Pleistocene; also the corresponding worldwide series of rocks. It is considered to be a period when the Tertiary is designated as an era.

**plot** To place survey data on a map or plat, to draw to scale. The term was formerly used in noun form as a syn. of *plat*.

**plucking** 1. A process of glacial erosion by which blocks of rock are loosened, detached, and borne away from bedrock by the freezing of water in fissures. See also *sapping*. 2. A process of stream erosion by which rock fragments are forcibly removed by the impact of water entering cracks in a rock.—Syn. *quarrying*.

**plug dome** A volcanic dome characterized by an upheaved, consolidated mass filling the conduit.

**plugging** The act or process of stopping the flow of water, oil, or gas in strata penetrated by a borehole or well, so that fluid from one stratum will not escape into another or to the surface. See *plugging*.

the sealing of a well that is to be abandoned. It is usually accomplished by pumping cement into the hole, setting a surface plug, and capping the hole with a metal plate.

**plugging back** The act or process of sealing off a lower section of a well bore with cement, or of blocking fluids below from rising to a higher section.

**plumbago** (plum-ba'-go) *graphite*.

**plume** A persistent pipelike body of hot material moving upward from the earth's mantle into the crust. Its surface expression may be a *hot spot*.

**plunge** *n.* The inclination of a fold axis or other linear feature, measured in the vertical plane. It is mainly used in the geometry of folds. Cf. *dip*.—*v.* 1. In surveying, to set the cross wire of a theodolite in the direction of a grade. 2. To reverse the direction of the telescope of a transit by rotating it 180 degrees about its horizontal axis. Syn. *transit*.

**plunge pool** The water occupying a deep hollow scoured in the bed of a stream at the foot of a waterfall, also the hollow or basin itself.

**plunging fold** A fold in which the hinge line is inclined to the horizontal. Cf. *nonplunging fold*, *doubly plunging fold*.

**pluton** (plu'-ton) 1. An igneous intrusion. 2. A body of rock formed by metamorphic replacement.—The term originally signified only deep-seated or plutonic bodies of granitoid texture.

**plutonic** (plu-ton-ik) 1. Pertaining

to igneous rocks formed at great depth. 2. Pertaining to rocks formed by any process at great depth.—Syn: *abyssal*; *deep-seated*; *hypogene*.

**plutonic rock** A rock formed at considerable depth by crystallization of magma and/or by chemical alteration. It is characteristically medium- to coarse-grained, of granitoid texture.

**plutonic water** *Juvenile water* in, or derived from, magma at a considerable depth, probably several kilometers. Cf: *magmatic water*; *volcanic water*.

**plutonism** (plu'-to-nism) 1. A general term for the phenomena associated with the formation of plutons. 2 The concept of the formation of the earth by solidification of a molten mass. The theory was promulgated by James Hutton in the 18th century. Cf: *neptunism*.

**plutonist** (plu'-to-nist) A believer in the theory of plutonism as promulgated by Hutton. Ant: *neptunist*.

**pluvial** (plu'-vi-al) 1. Pertaining to rain, or to precipitation. 2. Said of a climate characterized by relatively high precipitation. 3. Said of a geologic process or feature resulting from rain, e.g. pluvial denudation from landsliding and gully erosion.

**pneumatogenic** (pneu'-ma-to-gen'-ic) Said of a rock or mineral deposit formed by a gaseous agent. Cf: *hydrotogenic*. Syn: *pneumatolytic*.

**pneumatolysis** (pneu-ma-toi'-y-sis)

Alteration of a rock or crystallization of minerals by gaseous emanations derived from solidifying magma. Adj: *pneumatolytic*.

**pneumatolytic** (pneu'-ma-to-lyt'-ic) 1. Formed by pneumatolysis; *pneumatogenic*. 2. Applied to the stage of magmatic differentiation between the pegmatitic and hydrothermal stages. 3. Said of the effects of contact metamorphism adjacent to deep-seated intrusions.—The term is used even though in many instances the presence of a gas phase cannot be proved.

**pneumatotectic** (pneu-mo-tec'-tic) Said of processes and products of magmatic consolidation affected to some degree by gaseous constituents of the magma.

**pocket** 1. A small body of ore, e.g. in a mineralized crevice; also, a locally rich part of an ore deposit. 2. An enclosed or sheltered place along a coast. 3. A water hole in the bed of an intermittent stream. 4 A hollow or glen in a mountain. 5. A small body of ground water.

**pocket transit** *Brunton compass*.  
**pod** An ore body of an elongate or lenticular shape.

**Podzol** (Pod'-zol) A group of zonal soils having an organic mat and a very thin organic-mineral layer overlying a gray, leached A2 horizon and a dark brown, illuvial B horizon enriched in iron oxide, alumina, and organic matter. It develops under coniferous or mixed forests or under heath, in a cool to temperate moist climate. Etymol: Russian *podzol*, "ash

soil"

**poeciloblastic** (poe'-ci-lo-blas'-tic)  
*poikiloblastic*.

**poikilitic** (poi-ki-lit'-ic) Said of the texture of an igneous rock in which small grains of one mineral (e.g. plagioclase) are irregularly scattered without common orientation in a typically anhedral larger crystal of another mineral (e.g. pyroxene); also, said of the enclosing crystal. Cf: *ophitic*; *micropoikilitic*.

**poikiloblastic** (poi'-ki-lo-blas'-tic) Said of a texture of metamorphic rocks in which small grains of one mineral lie within larger meta-crysts of another. Also spelled: *poeciloblastic*.

**point bar** One of a series of low, arcuate ridges of sand and gravel developed on the inside of a growing meander by the slow addition of individual accretions accompanying migration of the channel toward the outer bank. Cf: *meander scroll*.

**point-bar deposit** A deposit consisting of a series of alternating point bars and intervening troughs.

**point diagram** A *fabric diagram* in which poles representing lineations, normals to fabric planes, or crystallographic directions have been plotted. Syn: *scatter diagram*.

**point group** One of the 32 crystal classes.

**point maximum** On a fabric diagram, a single area of concentration of poles representing the orientation of fabric elements.

**poised stream** A stream that is neither eroding nor depositing sediment. Cf: *graded stream*.

**Poisson's ratio** The ratio of the lateral unit strain to the longitudinal unit strain in a body that has been stressed longitudinally within its elastic limit. It is one of the *elastic constants*.

**polar glacier** (po'-lar) A glacier whose temperature is below freezing to considerable depth, or throughout, and on which there is no melting even in summer. See also: *temperate glacier*. Syn: *cold glacier*.

**polariscope** (po-lar'-i-scope) An instrument for studying the properties of and examining substances in polarized light.

**polarity** (po-lar'-i-ty) The magnetically positive (north) or negative (south) character of a magnetic pole.

**polarity-chronologic unit** A division of time distinguished on the basis of the record of magnetopolarity as expressed by *polarity-chronostratigraphic units*. In order of decreasing magnitude, ranks are *polarity period*, *polarity epoch*, and *polarity event*.

**polarity-chronostratigraphic unit** A subdivision of rock considered solely as the magnetic polarity record of a specific interval of geologic time.

**polarity epoch** A period of time during which the earth's magnetic field was predominantly or entirely of one polarity; specif., the time during which rocks of the corresponding *polarity interval*

formed It is the *polarity-chronologic unit* of middle rank

**polarity event** The shortest *polarity-chronologic unit*

**polarity interval** The fundamental unit of worldwide polarity-chronostratigraphic classification

The term is applied to rock not time; it is used in a spatial sense

**polarity period** The longest *polarity-chronologic unit*

**polarity reversal** *geomagnetic reversal*

**polarity zone** A unit of rock characterized by its polarity signature, the fundamental unit of polarity lithostratigraphic classification

**polarization** (po-lar-i-za'-tion) The modification of light so that its vibrations are restricted to a single plane

**polarized light** (po'-lar-ized) Light that has been changed by passage through a prism or other polarizer so that its transverse vibrations occur in a single plane It is used in the polarizing microscope for optical analysis of minerals or rocks in thin section

**polarizer** (po'-lar-i-zer) A medium for polarizing light In a petrographic microscope, it is the lower *Nicol prism* Cf *analyzer*

**polarizing microscope** (po'-lar-iz-ing) A microscope that uses polarized light and a revolving stage for analysis of petrographic thin sections Two prisms, one above and the other below the stage, polarize and analyze the light, the stage rotates about the line of vision See *petrographic microscope*

*crosscope*

**polar projection** One of a group of projections that are centered on a pole of a sphere Examples include any of several *azimuthal projections*

**polar symmetry** A type of crystal symmetry in which the two ends of the central crystallographic axis are not symmetrical Such a crystal is said to be *hemimorphic*

**polar wandering** 1 Short-period movement of the earth's poles resulting from wobbling of its axis 2 Long-period, more or less systematic displacement of the earth's poles, which may have occurred during the passage of geologic time

**polder** A tract of flat, low lying land (as in the Netherlands and Belgium) reclaimed and protected from the sea or other body of water by embankments, dikes, dams, or levees The term is usually reserved for coastal areas that are at or below sea level and that are constantly protected by an organized system of maintenance and defense

**pole** 1 Either end of the axis of a sphere 2 A point on a stereoscopic or equal-area projection that represents the projection of a lineation, the normal to a fabric plane, or a crystallographic direction, also, a point that represents the normal to any plane on a fabric diagram 3 In crystallography, a line that is perpendicular to a crystal face and passes through the center of the crystal 4 Either end of the axis of coiling in certain

shells or tests, e.g. the fusulinids.  
5. Either termination of the axis of a pollen grain or spore.

**pole-fleeing force** A component of forces resulting from the earth's rotation that is supposed to carry the crust away from the poles, toward the equator. The effectiveness of such a force has been shown to be negligible

**polish** (pol'-ish) An attribute of surface texture of a rock or particle, characterized by high luster and strong reflected light, e.g. *desert polish*.

**polished section** A section of rock or mineral that has been highly polished. It is used for study of opaque minerals by plane or polarized reflected light

**pollen** The several-celled reproductive unit of seed plants, enclosed in the microspore wall. Fossil pollen consists entirely of the microspore wall, or exine.

**pollen analysis** A branch of *palynology* dealing with the study of late Pleistocene and postglacial sediments by employing diagrams and maps to show the relative abundance of various pollen types in space and time; e.g. the identification and percentage determination of frequency of pollen grains of forest trees in peat bogs and lake beds as a means of dating fossil remains.

**poly-** A prefix meaning "many" or "very".

**polyconic projection** (pol'-y-con'-ic) A map projection in which a series of right circular cones are each tangent to the earth's surface

at successive latitudes, each parallel thus constructed serving as if it were the chosen standard parallel for a simple *conic projection*. All parallels (developed from the bases of the cones) are arcs of nonconcentric circles with their centers on the straight line generally representing the central meridian, all other meridians being curved lines drawn through the true divisions of the parallels. The scale along each parallel and along the central meridian is true, but it increases on the meridians with increasing distance from the central meridian. The projection is suitable for maps of small areas, e.g. quadrangles, and for areas of great longitudinal extent, such as Chile.

**polycrystal** (pol'-y-crys-tal) An assemblage of crystal grains of a mineral, of unspecified number, shape, size, orientation, or bonding, that together form a solid body

**polygenetic** (pol'-y-ge-net'-ic) 1. Resulting from more than one process of formation, derived from more than one source, or originating or developing at various places and times; e.g. said of a mountain range resulting from several orogenic episodes. 2. Consisting of more than one type of material, or having a heterogeneous composition; e.g. said of a conglomerate composed of materials from several sources.—*Cf.* *monogenetic*.

**polygeosyncline** (pol'-y-ge'-o-syn'-cline) A geosynclinal-geanticlinal

nal belt along the continental margin, receiving sediments from a borderland on its oceanic side. Cf: *monogeosyncline*.

**polygonal ground** (po-lyg'-o-nal) A form of patterned ground marked by polygonal arrangements of rock, soil, and vegetation, produced on a level or gently sloping surface by frost action; esp. a ground surface consisting of a large-scale network of *ice-wedge polygons*.

**polyhalite** (pol'-y-hal'-ite) An evaporite mineral,  $K_2MgCa_2(SO_4)_4 \cdot 2H_2O$ . It is commonly in pink, red, or gray masses in halite or potassium-salt deposits.

**polymetamorphism** (pol'-y-met'-a-mor'-phism) Polyphase or multiple metamorphism, whereby two or more successive metamorphic events have left their imprint upon the same rocks. The superimposed metamorphism may be of a higher or lower grade than the earlier type. See also: *retrograde metamorphism*.

**polymictic** (pol'-y-mic'-tic) 1. Said of a lake that is continually mixing and has no persistent thermal stratification. 2. Said of a clastic sedimentary rock composed of many rock types, e.g. a graywacke; also, said of the clasts of such a rock. Cf: *monomictic*; *oligomictic*.

**polymineralic** (pol'-y-min'-er-al'-ic) Said of a rock composed of two or more minerals; esp. said of an igneous rock consisting of more than one essential mineral. Cf: *monomineralic*.

**polymorph** (pol'-y-morph) 1. A crystal form of a substance that displays polymorphism. 2. An organism exhibiting polymorphism; also, one of the forms of such an organism.

**polymorphism** (pol-y-mor'-phism) 1. The characteristic of a chemical substance to crystallize in more than one form, e.g. rhombic and monoclinic sulfur. Such forms are polymorphs. 2. The existence of a species in several forms independent of sexual variations; esp. referring to different types of individuals within a colony, as in bryozoans.—Adj: *polymorphic*. See also: *dimorphism*.

**polyp** (pol'-yp) A typical individual coelenterate, with a hollow tubular or columnar body terminating at the top in a central mouth surrounded by tentacles. It is closed below, and attached to the bottom (as in *Hydra*) or more or less directly continuous with other individuals of a compound animal (as in most corals).

**polyphyletic** (pol'-y-phy-let'-ic) Evolving from more than one ancestral stock. Cf: *monophyletic*.

**polysynthetic twinning** (pol'-y-syn-thet'-ic) Repeated twinning of three or more individuals according to the same twin law and on parallel composition planes; e.g. albite twinning of plagioclase. It is often revealed megascopically by striated surfaces. Cf: *cyclic twinning*.

**polytypic** (pol-y-typ'-ic) 1. Said of a taxon that includes several units of the next lower category, e.g. a



genus with several species. 2. Referring to a species consisting of subspecies that replace each other geographically.

**pontic** (pon'-tic) Pertaining to sediments or facies deposited in comparatively deep and motionless water, such as an association of black shales and dark limestones deposited in a stagnant basin. Etymol: Greek *pontos*, "sea". Cf: *euxinic*.

**pool** 1. A subsurface accumulation of oil or gas in porous and permeable rock. See also: *oil pool*; *gas pool*. 2. A body of impounded water, artificially confined above a dam or the closed gates of a lock.

**poorly graded** 1. A geologic term for *poorly sorted*. 2. An engineering term pertaining to a soil or sediment in which all the particles are of about the same size or in which a continuous distribution of particle sizes from the coarsest to the finest is lacking — Ant: *well-graded*.

**poorly sorted** Said of a clastic sediment or rock that consists of particles of many sizes mixed together in an unsystematic manner so that no one size class predominates. Ant: *well-sorted*. See also: *poorly graded*.

**population** (pop-u-la'-tion) 1. All the individuals of the same species, or of a group of closely related species. 2. Formerly, all organisms occupying a certain area or environment. 3. In statistics, any theoretical group of items or samples, all of which are capable of

being measured statistically in one or more respects.

**porcelaneous chert** (por-ce-la'-neous) A hard, opaque chert having a smooth fracture surface and a typically china-white appearance resembling chinaware or glazed porcelain.

**porcelanite** (por-ce-lan'-ite) *porcellanite*.

**porcellanite** (por-cel'-la-nite) A dense siliceous rock having the texture, dull luster, and general appearance of unglazed porcelain; it is less hard, dense, and vitreous than chert. The term has been used for an impure chert; for a baked clay or shale found in the roof or floor of a burned-out coal seam, and for a fine-grained acidic tuff compacted by secondary silica. Also spelled: *porcelanite*.

**pore** 1. A small to minute opening or interstice in a rock or soil. 2. A small opening in the wall or shell of an invertebrate animal, e.g. from the exterior through the tubular plates of a cystoid.

**pore diameter** The diameter of the large sphere that might be contained within a pore.

**pore pressure** *neutral stress*.

**pore space** The open space in a rock or soil, considered collectively.

**poriferan** (po-rif'-er-an) *sponge*

**porosimeter** (po-ro-sim'-e-ter) An instrument used to determine the porosity of a rock sample by comparing the bulk volume of the sample with the aggregate volume of the pore spaces within it.

**porosity** (po-ros'-i-ty) The ratio of

the aggregate volume of interstices in a rock or soil to its total volume. It is usually stated as a percentage. Cf: *effective porosity*.

Syn: *total porosity*. See also: *primary porosity*; *secondary porosity*.

**porous** (po'-rous) Containing voids, pores, or interstices, which may or may not interconnect. The term usually refers to smaller openings than those of a *cellular* rock.

**porphyroblast** (por'-phy-ro-blast') *metacryst*.

**porphyroclastic** (por'-phy-ro-clas'-tic) Said of a metamorphic texture characterized by large strained *metacrysts* within a finely recrystallized matrix of *neoblasts* that are free of strain.

**porphyry** (por'-phy-ry) An igneous rock of any composition that contains conspicuous *phenocrysts* in a fine-grained groundmass, a porphyritic igneous rock

**porphyry copper deposit** A large body of rock, typically porphyry, that contains disseminated chalcopyrite and other sulfide minerals. Such deposits are mined in bulk on a large scale, generally in open pits, for copper and by-product molybdenum. Most deposits are 3 to 8 km across, and of low grade (less than 1% Cu). *Supergene enrichment* has been very important at most deposits, as without it the grade would be too low to permit mining.

**portal** (por'-tal) *entry*.

**portland cement** A cement produced by fine-grinding a carefully proportioned mixture of lime-

stone and shale (or equivalent raw materials); heating the mixture to incipient fusion in a rotary kiln; and fine-grinding the resulting clinker. It was developed in 1824 by Joseph Aspdin in England; the name is for a resemblance to Portland stone, a widely used British building stone. The U.S. industry dates from 1875.

**positive** (pos'-i-tive) adj. Said of uniaxial crystals in which the extraordinary index of refraction is greater than the ordinary index; and of biaxial crystals in which the intermediate index of refraction,  $\beta$ , is closer in value to the lowest index,  $\alpha$ , than to the highest,  $\gamma$ . See also: *optical character* —n. *positive element*.

**positive area** *positive element*.

**positive element** A large structural feature or area that has had a long history of progressive uplift; also in a relative sense one that has been stable or has subsided less than neighboring negative elements. Syn. *positive area*; *positive*.

**positive elongation** As seen in thin section, elongation of an anisotropic crystal that is parallel to the slower of the two plane-polarized rays. Cf: *negative elongation*.

**positive movement** Uplift of a part of the earth's crust, actual in relation to sea level or relative in relation to adjacent parts of the crust. Cf: *negative movement*.

**positive ore** An ore body that has been exposed and developed on four sides, and for which tonnage and quality estimates have been

made Cf *developed reserves proved reserves.*

**positive shoreline** *shoreline of submergence.*

**possible ore** (pos'-si-ble) A mineral deposit whose existence and extent is postulated on the basis of past geologic and mining experience. Syn *future ore* Cf *inferred ore indicated ore, potential ore.*

**posterior** (pos-te'-ri-or) adj Situated toward the back of an animal, or at or toward the hinder part of the body, as opposed to *anterior*

**postmineral** (post-min'-er-al) adj In economic geology, said of a structural or other feature formed after mineralization Cf *premineral, intermineral.*

**postorogenic** (post'-or-o-gen'-ic) Said of a geologic process or event occurring after a period of orogeny or said of a rock or feature so formed

**pot** 1 A *pothole* or other natural pit or depression, often containing water 2 A sedimentary deposit in the shape of a pot, in distinctively different material, e.g. bodies of sandy silt in the upland gravels of Maryland and Virginia 3 A concretion or other rounded object in the roof of a coal seam, whose bottom resembles that of a pot 4 A colloquial syn of *seismic detector*

**potash** (por' ash) 1 Potassium carbonate  $K_2CO_3$  2 A term loosely used for potassium oxide, potassium hydroxide, or even for potassium in such informal expressions as *potash feldspar* or *potash spar* **potash feldspar** A misnomer for

*potassium feldspar*

**potash spar** An informal commercial term for potassium feldspar, i.e. *orthoclase* or *microcline*, or for a feldspar mixture assaying at least 10%  $K_2O$  Cf *soda spar.*

**potassic** (po-tas'-sic) Said of a rock or mineral containing a significant amount of potassium

**potassium-argon age method** (po-tas'-si-um) Determination of the age of a mineral or rock in years, based on measurement of the ratio of radiogenic argon-40 to potassium-40 and the known radioactive decay rate of potassium-40 to argon-40 Abbrev *K-Ar age method*

**potassium bentonite** A potassium-bearing clay of the illite group, formed by alteration of volcanic ash, a *metabentonite* consisting of randomly interstratified layers of illite and montmorillonite with a ratio of 4 to 1 (potassium occupying about 80% of the exchangeable cation positions of the mica portion) Syn *K bentonite.*

**potassium feldspar** An alkali feldspar containing the Or molecule ( $KAlSi_3O_8$ ), e.g. *orthoclase*, *microcline*, *sanidine*, and *adularia* See also *potash spar* Syn *K-feldspar*

**pot clay** 1 A refractory clay (fire-clay) suitable for the manufacture of the melting pots in which glass is produced 2 A clay bed associated with coal measures 3 A kaolin rich residual clay

**potential** (po-ten'-tial) Any of several different scalar quantities, each of which involves energy as

a function of position or of condition; e.g. the *fluid potential* of ground water.

**potential barrier** The resistance to change from one energy state to another in a chemical system, which must be overcome by *activation energy*.

**potential ore** 1 As yet undiscovered mineral deposits. 2. A known mineral deposit for which recovery is not yet economically feasible.—Cf: *possible ore*; *inferred ore*; *indicated ore*. See also *resources*; *reserves*

**potentiometer** (po-ten'-ti-om'-e-ter) An electrical instrument for the precise measurement of low-level direct-current voltages

**potentiometric map** (po-ten'-ti-o-met'-ric) A subsurface contour map showing the elevation of a potentiometric surface

**potentiometric surface** An imaginary surface representing the total head of ground water and defined by the level to which water will rise in a well. The water table is a particular potentiometric surface. Syn. *piezometric surface*

**pothole** 1 A smooth deep bowl-shaped or cylindrical hollow, formed in the rocky bed of a stream by the grinding action of stones or coarse sediment being whirled around by an eddy in the stream current, as at a strong rapid or the foot of a waterfall. 2 A *moulin* or *giant's kettle*. 3 A term with various local meanings, e.g. in Death Valley, Calif., for a circular opening, about a meter in diameter, filled with brine and

lined with halite crystals.

**potter's clay** A plastic clay free from iron and devoid of fissility, suitable for modeling or making of pottery or adapted for use on a potter's wheel. It is white after firing. Cf: *pipe clay*.

**Pottsville** (Potts-vil'-li-an) Lower Pennsylvanian of eastern North America

**powder diffraction** X-ray diffraction by a powdered, crystalline sample, commonly observed by a camera or a recording diffractometer

**pozzolan** (poz' zo-lan) Siliceous material such as diatomaceous earth, opaline chert, and certain tuffs, which can be finely ground and combined with *portland cement* (in a proportion of 15 to 40 percent by weight). The pozzolan reacts with calcium hydroxide that is liberated as concrete hardens, forming compounds with cementitious properties. Pozzolans also counteract the adverse effects of certain undesirable *aggregates* that may have to be used in concrete. Portland-pozzolan cements are highly resistant to penetration and corrosion by salt water. The name comes from the town of Pozzuoli, Italy, near which occurs a leucite tuff that was used in cement in Roman times. Also spelled *pozzolana*; *puzzolan*, *puzzuolana*.

**prairie** (prai'-rie) 1 An extensive tract of level to rolling grassland, generally treeless, in the temperate latitudes of the interior of North America (esp. in the Mis-

Mississippi Valley region), characterized by a deep, fertile soil and by a covering of tall, coarse grass and herbaceous plants. See also: *steppe*. 2. One of a series of grassy plains into which the true prairies of the Mississippi Valley region merge on the west, whose treeless state is due to aridity—Etymol: French, "meadow, grassland"

**Pratt hypothesis** A concept of the mechanism of *isostasy*, proposed by G.H. Pratt, that postulates an equilibrium of crustal blocks of varying density; thus the topographically higher mountains would be less dense than topographically lower units, and the depth of crustal material would be everywhere the same. Cf: *Airy hypothesis*

**Precambrian** (Pre-cam'-bri-an) All geologic time, and its corresponding rocks, before the beginning of the Paleozoic; it is equivalent to about 90% of geologic time. See also: *Proterozoic*.

**precession camera** (pre-ces'-sion) An X-ray camera used to register the diffraction from a single crystal showing individual layers of the reciprocal lattice without distortion.

**precious metal** (pre'-cious) Gold, silver, or any of the minerals of the platinum group.

**precious stone** A relatively rare, durable gemstone of unusual beauty, specif. diamond, ruby, emerald, and sapphire.

**precipitation** (pre-cip'-i-ta'-tion) 1. Water that falls to the surface from the atmosphere as rain,

snow, hail, or sleet. It is measured as a liquid-water equivalent regardless of the form in which it fell. 2. The process of separating mineral constituents from a solution by evaporation (e.g. halite, anhydrite), or from magma to form igneous rocks.

**precision depth recorder** (pre-ci'-sion) An *echo sounder* having an accuracy better than 1 in 3000.

**preconsolidation pressure** (pre'-con-sol'-i-da'-tion) Pressure exerted on unconsolidated sediment by overlying material that resulted in compaction; the overburden may have been removed later by erosion.

**preferred orientation** In structural geology, nonrandom orientation of planar or linear fabric elements, including crystallographic directions (*lattice-preferred orientation*) or elongation/flattening axes of crystals (*shape-preferred orientation*).

**pregeologic** (pre'-go-o-log'-ic) 1. Antedating reliable geologic data or theory. 2. Referring to the part of geologic history that antedates the oldest rocks (about 3-4.5 b.y. ago).

**preglacial** (pre-gla'-cial) 1. Pertaining to the time preceding a period of glaciation, specif. that immediately before the Pleistocene Epoch. 2. Said of material underlying glacial deposits.

**preliminary waves** (pre-lim'-i-nar-y) The body waves of an earthquake. They reach the seismograph before the surface waves by virtue of their high speeds in the

interior of the earth. They include both P-waves (first preliminary waves) and S-waves (second preliminary waves).

**premineral** (pre-min'-er-al) adj. In economic geology, said of a structural or other feature extant before mineralization Cf: *inter-mineral*; *postmineral*.

**preoccupied name** (pre-oc'-cu-pied) In taxonomy, a name that is unavailable for use because given previously to a different taxon.

**preorogenic** (pre'-or-o-gen'-ic) Said of the initial phase of an *orogenic cycle*, prior to the climactic orogeny. It is the time of formation of geosynclines and intrusion of ultramafic plutonic rocks. See also: *orogenic phase*.

**pressure** (pres'-sure) 1. The force exerted across a real or imaginary surface divided by the area of that surface; the force per unit area. 2. A commonly used short form for *geostatic pressure*.

**pressure figure** A pattern resembling a six-rayed star, produced by intersecting lines of parting due to gliding, when certain minerals, esp. mica, are compressed by a blunt point.

**pressure gradient** 1. The rate of variation of pressure in a given direction at a fixed time, e.g. with depth in the ocean. 2. Loosely, the magnitude of the pressure gradient.—Cf: *hydraulic gradient*.

**pressure head** The height of a column of liquid supported, or capable of being supported, by pressure at a point in the liquid, e.g. the height that a column of water

rises in a tightly cased well. The pressure head is commonly expressed with reference to the land surface at the well or to some other convenient level.

**pressure release** The outward-expanding force that is released within rock masses by unloading, as by erosion of overlying rocks or by removal of glacial ice. It results in pulling away of the outer layers of the mass, especially in massive plutonic rocks, causing them to split into great shells or spalls; for example, in Yosemite Valley, California.◊

**pressure-release jointing** *Exfoliation* that occurs in once deeply buried rock that erosion has brought nearer the surface, thus releasing its confining pressure. See also: *sheeting*.

**pressure shadow** In structural petrology, aggregates of new grains growing on opposed sides of a host porphyroblast or detrital grain, thereby producing an elongate structure. This structure is generally aligned parallel to a foliation and may define a lineation.

**pressure solution** Solution in a sedimentary rock occurring preferentially at the contact surfaces of grains, where the external pressure exceeds the hydraulic pressure of the interstitial fluid. It results in enlargement of the contact surfaces and thereby reduces pore space and tightly welds the rock. See also: *Riecke's principle*.

**pressure tube** A deep cylindrical hole formed in a glacier by the

sinking of an isolated stone that has absorbed more solar radiation than the surrounding ice.

**pressure wave** *P wave*.

**primärrumpf** (pri-mär'-rumpf) An upwarped, progressively expanding landscape or plain, with a rise so slow that degradation keeps pace with uplift.

**primary** (pri'-ma-ry) 1. Said of minerals, textures, and structures of a rock that came into existence at the time the rock was formed, as opposed to *secondary*. 2. Said of a mineral deposit unaffected by supergene enrichment. 3. Said of a metal obtained from ore rather than from scrap. 4. Said of a youthful shoreline where waves have not had time to produce notable effects, e.g. a shoreline shaped by recent lava flows.

**primary dip** The slight dip of a bedded deposit assumed at its moment of deposition. Syn: *original dip*. Cf: *initial dip*.

**primary dolomite** A dense finely textured well-stratified unfossiliferous dolomite rock formed in place by direct chemical or biochemical precipitation from sea water or lake water. Syn: *orthodolomite*.

**primary flowage** Movement within an igneous rock that is still partly fluid.

**primary geosyncline** *orthogeosyncline*.

**primary gneiss** A rock that exhibits planar or linear structures characteristic of metamorphic rocks, but lacks observable granulation or recrystallization and is there-

fore considered to be of igneous origin.

**primary magma** A magma originating below the earth's crust. It is sometimes used as a syn. of *parental magma*.

**primary mineral** A mineral formed at the same time as the rock enclosing it, by igneous, hydrothermal, or pneumatolytic processes, and that retains its original composition and form. Cf: *secondary mineral*.

**primary phase** The only crystalline phase capable of existing in equilibrium with a given liquid; it is the first to appear on cooling from a liquid state, and the last to disappear on heating to the melting point.

**primary porosity** The porosity that developed during the final stages of sedimentation or that was present within sedimentary particles at the time of deposition. Cf: *secondary porosity*.

**primary structure** 1. In sedimentary rocks, a structure determined by conditions of deposition, before lithification, e.g. bedding and ripple marks. 2. In an igneous rock, a structure that originated at the same time as the formation or emplacement of the rock but before its final consolidation; e.g. pillow structure in basalt.

**primary wave** *P wave*.

**prime meridian** An arbitrary meridian selected as a reference line having a longitude of zero degrees and used as the origin from which other longitudes are reckoned east and west to 180 degrees;

specif the meridian that passes through Greenwich, England

**primeval** (pri-me'-val) Pertaining to the earliest ages of the earth, e.g. said of lead that is associated with so little uranium (as in some meteorites) that the Pb-isotope composition has not changed appreciably in five billion years

**primitive circle** (prim'-i-tive) That circle on a *stereographic projection* which is the intersection of the stereographic plane with the sphere of reflection; it is the sphere's equatorial circle

**principal axes of strain** (prin'-i-pal) Three mutually perpendicular axes corresponding to the three axes of a body that were also mutually perpendicular before deformation; also described as the axes of the strain ellipsoid. The longest is the axis of elongation and the shortest is the axis of shortening

**principal axes of stress** Three mutually perpendicular axes that are perpendicular to the *principal planes of stress*

**principal axis 1** That crystallographic axis which is the most prominent. In the tetragonal and hexagonal systems, it is the vertical or *c* axis; in the orthorhombic, monoclinic, and triclinic systems, it is usually the *a* axis, although in monoclinic minerals such as epidote it may be the *b* axis. 2 In experimental structural geology, one of the *principal axes of stress* or *principal axes of strain*

**principal meridian** A *central meridian* on which a rectangular

grid is based, specif one of a pair of coordinate axes (along with the *base line*) used in the U.S. Public Land Survey system. It consists of a line extending north and south along the astronomic meridian passing through the initial point, along which standard township, section, and quarter-section corners are established. The principal meridian is the line from which the survey of the township boundaries is initiated along the parallels

**principal planes of stress** Three mutually perpendicular planes, upon each of which the resultant stress is normal, i.e. on which shear stress is zero. See also *principal axes of stress*

**principal stress** A stress that is perpendicular to one of three mutually perpendicular planes that intersect at a point in a body on which the shearing stress is zero, a stress that is normal to a principal plane of stress. The three principal stresses are identified as least or minimum, intermediate, and greatest or maximum. See also *mean stress*

**prism 1** A crystal form having three, four, six, eight, or twelve faces, with parallel intersection edges, and which is open only at the two ends parallel to the intersection edges of the faces. 2 A long, narrow, wedge-shaped body of sediments, e.g. one of the great conglomerates of the sedimentary record. It is typically formed during orogenic deformation, like the arkoses found in fault troughs.



See also *geosynclinal prism*.

**prismatic** (pris-mat'-ic) 1 Said of a sedimentary particle whose length is 1.5 to 3 times its width Cf *tabular* 2 Pertaining to a sedimentary *prism*. 3 Pertaining to a crystallographic *prism*. 4 Said of a crystal with one dimension markedly longer than the other two, also, said of a metamorphic texture characterized by such crystals

**probable ore** (prob'-a-hle) 1 *indicated ore* 2 A mineral deposit adjacent to developed ore but not yet proven by development

**probe** Any instrument that is placed in the environment to be measured, e.g. a density probe in a drill hole

**problematic fossil** (prob-lem-at'-ic) A natural object of nature, or marking in a rock, resembling a fossil but having a doubtful organic nature or origin Cf *pseudofossil* Syn *dubiofossil*

**Procellarian** (Pro-cci-lar-i-ar') 1 Pertaining to lunar lithologic map units and topographic forms constituting, or closely associated with, the maria Such features were formerly mapped as the Procellarian System, but are now considered a unit of the Imbrian System 2 Said of the time interval during which the Procellarum Group was developed

**prodelta** (pro'-del-ta) The part of a delta that is below the effective depth of wave erosion, lying beyond the delta front, and sloping gently down to the floor of the basin into which the delta is ad-

vancing and where clastic river sediment ceases to be a significant part of the basin-floor deposits Cf *intradelta*

**prod mark** 1 An indicator of slip direction on a slickensided fault surface, consisting of a groove made by a clast 2 A short *tool mark* oriented parallel to the current of a stream and produced by an object that plowed into and was then raised above the bottom; its longitudinal profile is asymmetrical

**producer** (pro-duc'-er) A producing well

**producing zone** (pro-duc'-ing) The rock stratum of an oil field that will produce petroleum or gas when penetrated by a well Often incorrectly referred to as "producing horizon"

**profile** 1 *profile section*. 2 A graph that shows the variation of one property, such as gravity, with respect to another, such as distance 3 In seismic prospecting the data recorded from one shot point by a number of groups of detectors 4 A vertical section of a water table or other potentiometric surface, or of a body of surface water 5 *soil profile*. 6 *profile of equilibrium*.

**profile of equilibrium** 1 The longitudinal profile of a graded stream, or of one whose gradient at every point is just sufficient to enable it to transport the load of sediment available to it Syn. *graded profile*. 2 The slightly concave slope of the floor of a sea or lake, taken in a vertical plane

and extending away from the shoreline, being steepest near the shore and having a gradient such that the amount of sediment deposited by waves and currents is balanced by the amount removed by them. The concept is hypothetical. Syn: *graded shoreline*.

**profiler** (pro'-fil-er) A low-energy marine seismic system employing one or two recording channels and usually a *sparker*. Often the only record produced is a single-channel plot on electrosensitive paper showing water-bottom reflections and limited penetration into the sedimentary section.

**profile section** A diagram or drawing that shows along a given line the configuration or slope of the surface of the ground as it would appear if intersected by a vertical plane. The vertical scale is often exaggerated. See also. *line of section*. Syn: *profile*.

**proglacial** (pro-gla'-cial) Immediately in front of or just beyond the outer limits of a glacier or ice sheet, generally at or near its lower end; said of lakes, streams, deposits, and other features produced by or derived from the glacier ice.

**proglacial lake** A lake formed just beyond the frontal margin of an advancing or retreating glacier, generally in direct contact with the ice. Cf: *glacier lake*.

**prograding shoreline** (pro-grad'-ing) A shoreline that is being built forward or outward into a sea or lake by deposition and accumula-

tion, e.g. in a delta. Ant: *retrograding shoreline*.

**projected profile** (pro-ject'-ed) A diagram that includes only those features of a series of profiles, usually drawn along several regularly spaced and parallel lines on a map, that are not obscured by higher intervening ground; it gives a panoramic effect with a distant skyline, a middleground, and a foreground, and it represents an outline landscape-drawing showing only summit detail. Cf: *composite profile*.

**projection** (pro-jec'-tion) A diagram or representation of three-dimensional space relations produced by passing lines from various points to their intersection with a plane; a *map projection*.

**promontory** (prom'-on-to'-ry) 1. A high cape with a bold termination, a *headland*. 2. A bluff or prominent hill overlooking or projecting into a lowland.

**propane** An inflammable gaseous hydrocarbon, formula  $C_3H_8$ , of the methane series. It occurs naturally in crude petroleum and natural gas. It is also produced by cracking and is used primarily as a fuel and in the making of chemicals.

**proportional limit** (pro-por'-tional) The highest value of stress that a material can undergo before it loses its linear relationship between stress and strain, i.e. before it ceases to behave according to Hooke's law.

**propylite** (prop'-y-lite) An andesitic rock resembling greenstone and

consisting of such minerals as calcite, chlorite, epidote, serpentine, quartz, pyrite, and iron oxides. It results from hydrothermal alteration.

**proration** (pro-ra'-tion) Restriction of oil and gas production by a regulatory commission, usually in anticipation of market demand. It is the basis on which *allowables* are assigned.

**prospect** (pros'-pect) 1. An area that is a potential site of mineral deposits, based on preliminary exploration. 2. Sometimes, an area that has been explored in a preliminary way but has not given evidence of economic value. 3. An area to be searched by some investigative technique, e.g. geophysical prospecting. 4. A geologic or geophysical anomaly, especially one recommended for additional exploration — A prospect is distinct from a *mine* in that it is non-producing.

**prospecting** Searching for economically valuable deposits of fuel or minerals. Cf. *exploration*.

**prospector** (pros'-pec-tor) An individual engaged in prospecting for valuable mineral deposits, generally working alone or in a small group, and on foot with simple tools or portable detectors. The term implies an individual searching on his own behalf, rather than an employee of a mining company.

**prospect pit** Any hole, pit, shaft, or tunnel made for the purpose of prospecting mineral-bearing ground.

**Proterozoic** (Prot'-er-o-zo'-ic) 1. The more recent of two great divisions of the Precambrian. Cf. *Archeozoic*. Syn: *Algonkian*. 2. The entire Precambrian.

**protist** (pro'-tist) Any organism assigned to the kingdom Protista, which includes forms with both plant and animal affinities, e.g. protozoans, bacteria, and some algae, fungi, and viruses. No agreement exists on the limits of nomenclature of the Protista.

**Protista** Kingdom of one-celled organisms.

**Protochordata** (Pro'-to-chor-da'-ta) A phylum or subphylum of animals that possess a notochord during some part of their life history but do not have a bony skeleton or spinal column. They occupy a position intermediate between invertebrates and vertebrates; they are included by some in the Chordata.

**protoclastic** (pro-to-clas'-tic) 1. Said of igneous rocks in which the earlier formed crystals have been broken or deformed due to differential flow of the magma before complete solidification. 2. Said of an igneous rock containing deformed *xenocrysts*. 3. Said of the texture characteristic of an early stage of *cataclasis*, with a very small amount of finite strain.

**protoconch** (pro'-to-conch) 1. The first portion of the embryonic shell of a cephalopod, its preservation in fossil and in living forms being uncertain. The term is sometimes applied to the first chamber of the shell. 2. The api-

cal, usually smooth whorl of the fully formed embryonic shell of a gastropod.

**protodolomite** (pro-to-do'-lo-mite)

A crystalline calcium-magnesium carbonate with a disordered structure, in which the metallic ions occur in the same crystallographic layers instead of in alternate layers as in the mineral dolomite.

**protoquartzite** (pro-to-quartz'-ite)

A well-sorted, quartz-enriched sandstone that lacks the well-rounded grains of an *orthoquartzite*; specif. a lithic sandstone intermediate in composition between subgraywacke and orthoquartzite. It commonly forms *shoestring sands*.

**protore** (prot'-ore) The rock below the sulfide zone of *supergene enrichment*, the primary, subeconomic material. See also: *oxidized zone*, *sulfide zone*.

**prototype** (pro'-to-type) An ancestral form; the most primitive form in a group of related organisms.

**protozoan** (pro-to-zo'-an) A single-celled organism belonging to the phylum Protozoa, characterized by the absence of tissues and organs. Some members have both plant and animal affinities (flagellates); other members are characterized by their development of calcareous and siliceous skeletons (foraminifers, radiolarians).

**prove** In economic geology, to establish, by drilling, trenching, underground openings, or other means, that a given deposit of a valuable substance exists, and

that its grade and dimensions equal or exceed some specified amounts.

**proved ore** *proved reserves*.

**proved reserves** Reserves of metallic and nonmetallic minerals, and of oil and gas, for which reliable quantity and quality estimates have been made. Cf: *developed reserves*, *positive ore*. Syn. *proved ore*.

**provenance** (prov'-e-nance) A place of origin; specif. the area from which the constituent materials of a sedimentary rock or facies were derived. Also, the rocks of which this area is composed. Cf: *distributive province*.

**proven reserves** Oil that has been discovered and determined to be recoverable but is still in the ground.

**province** (prov'-ince) 1. A *geologic province* or a *physiographic province*. 2. Part of a region, isolated and defined by climate and topography, that is characterized by a particular group of organisms. 3. A group of associated plant or animal communities.

**provincial series** (pro-vin'-cial) A series of strata recognized in a particular region and involving a major division of time within a period; e.g. the Wolfcampian Series within the Permian System in west Texas and New Mexico.

**provincial species** A species confined to a particular geographic or ecologic province.

**proximal** (prox'-i-mal) 1. Said of an ore deposit formed adjacent to a volcanic feature to which it is

genetically related and from which its constituents have been derived. 2. Said of a sedimentary deposit consisting of coarse clastics, formed nearest the source area. 3. In invertebrates next to or nearest the point of attachment or place of reference, a point conceived of as central, or the point of view — Ant *distal*.

**proximate analysis** (prox'-i-mate)

The determination of compounds contained in a mixture; for coal, the determination of moisture, volatile matter, ash, and fixed carbon (by difference) Cf *ultimate analysis*.

**psammite** (psam'-mite) 1. A sandstone or arenite. 2. The metamorphic derivative of arenite — Etymol. Greek *psammos*, "sand" See also *pelite* *psophite*.

**psophite** (psē'-phite [see'-fite]) 1. A gravel conglomerate, breccia or other coarse sediment. It is equivalent to the Latin-derived term *rudite*. 2. The metamorphic derivative of rudite — Etymol. Greek *psēphos*, "pebble" See also *pelite* *psammite*.

**pseudo-** A prefix meaning false or spurious. In most scientific terms it denotes deceptive resemblance to the substance to whose name it is prefixed.

**pseudobreccia** (pseu-do-bre'-cia) A partially dolomitized limestone, with a mottled appearance that gives the rock a texture mimicking that of a breccia, or with a weathered surface that appears fragmental. It is produced diagenetically by selective growth

of patchy recrystallized masses of coarse calcite in a lighter-colored and less-altered matrix of calcareous mud.

**pseudoconglomerate** (pseu'-do-con-glom'-er-ate) A rock that resembles a normal sedimentary conglomerate, e.g. a *crush conglomerate*, or an aggregate of rounded boulders produced in place by *spheroidal weathering*.

**pseudo cross-bedding** 1. An inclined bedding produced by deposition in response to ripple-mark migration, and characterized by foreset beds that appear to dip into the current. 2. A structure resembling cross-bedding, caused by slumping and sliding of a semi-consolidated mass of sediments.

**pseudofossil** (pseu'-do-fos'-sil) A natural object, structure or mineral of inorganic origin that may resemble or be mistaken for a fossil. Cf *problematic fossil*.

**pseudomorph** (pseu'-do-morph) A mineral whose outward crystal form is that of another mineral, it is described as being "after" the mineral whose outward form it has, e.g. quartz after fluorite. Adj. *pseudomorphous*.

**pseudoporphyrictic** (pseu'-do-por'-phyrit-ic) Said of the texture of an igneous rock in which larger crystals have developed in a macrocrystalline groundmass, but were formed, at least in part, after the rock solidified (e.g. large potassium feldspar crystals in a granite).

**pseudo ripple mark** A bedding-plane feature resembling a ripple

mark but attributed to lateral pressure caused by slumping or to local, small-scale tectonic deformation

**pseudosymmetry** (pecu-do-sym-mc-try) Apparent symmetry of a crystal, resembling that of another system, it is generally due to twinning

**pseudotachylyte** (pseu-do-tach'-y-lyte) 1 A dense rock produced in the compression and shear associated with intense fault movements, involving extreme mylonitization and/or partial melting. 2 A dark gray or black rock that externally resembles *tachylyte* and that typically occurs in it regularly branching veins

**pseudovolcano** (pseu'-do-vol-ca'-no) A large circular hollow or crater held not to be associated with volcanic activity, e.g. a crater of doubtful meteoritic origin or one that is thought to be the result of phreatic explosion or cauldron subsidence

**psi** 1 A negative logarithmic transformation (to the base 2) of settling velocity in cm/sec, analogous to the *phi* grade scale. Etymol. Greek letter  $\psi$ . 2 Abbreviation for pounds per square inch. **psilomelane** (psi-lom-e-lane) A general field term for mixtures of manganese minerals, or for a botryoidal, colloform manganese oxide whose mineral composition is not specifically determined (Ywad).

**pteridophyte** (pte-nd'-o-phyte [te-nd'-o-fite]) A fernlike, vascular plant that reproduces by spores

Members of this division, which appeared in the Devonian, include lycopods, horsetails or scouring rushes, and ferns Cf *spermatophyte*, *bryophyte*, *thallophyte*.

**pterodactyl** (pte-ro-dac'-tyl) 1 Strictly, any member of the more advanced of two suborders into which the order Pterosauria is divided, characterized by a reduced tail and a tendency toward loss of teeth and increase in size. Range, Middle Jurassic to Upper Cretaceous. 2 More loosely, any *pterosaur*.

**pteropod** (pte'-ro-pod) Any marine gastropod belonging to the order Pteropoda, which includes pelagic forms sometimes with shells. The shells are generally conical and composed of aragonite. Range, Cretaceous to present.

**pterosaur** (pte'-ro-saur) A member of the order Pterosauria, reptiles highly adapted to flight. They were characterized by extreme elongation of the fourth digit of the hand for support of a membranous wing, and by reduction of the hind limbs. Range, Upper Triassic to Upper Cretaceous. Partial syn. *ptero-dactyl*.

**ptygmatic folia** (ptyg-mat'-ic [tig-mat'-ic]) (granitic material within migmatite or gneiss, having the appearance of disharmonic folds. The genesis of this type of "folding" is controversial.

**puddingstone** A popular name applied chiefly in Great Britain to a conglomerate consisting of well-rounded pebbles whose colors are

in marked contrast with the fine-grained matrix or cement.

**pulsation theory** (pul-sa'-tion)

Theory proposing that eustatic movements of sea level resulted in simultaneous transgression followed by regression of epicontinental seas on all continents.

**pumice** (pum'-ice) A light-colored cellular glassy rock commonly having the composition of *rhyolite*. It is often sufficiently buoyant to float on water and is economically useful as a lightweight aggregate and as an abrasive. Adj: *pumiceous*. Cf: *scoria*; *pumicite*.

**pumice flow** A type of *pyroclastic flow* in which a large proportion of the fragments are of pumice. Cf: *ash flow*.

**pumicite** (pum'-i-cite) An accumulation of angular shards and cell walls of rhyolitic glass, with a particle diameter of less than 4 mm. It differs from pumice only in grain size.

**Pumpelly's rule** (Pum-pel'-ly) The generalization that the axes and axial surfaces of minor folds of an area are congruent with those of the major fold structures of the same phase of deformation.

**pure shear** A strain in which the body is elongated in one direction and shortened at right angles to it. Cf: *simple shear*.

**purple copper ore** *bornite*.

**puzzolan** (puz'-zo-lan) *pozzolan*.

**P wave** That type of seismic wave that involves particle motion (alternating compression and expansion) in the direction of propaga-

tion. It is the fastest of the seismic waves, traveling 5.5-7.2 km/sec in the crust and 7.8-8.5 km/sec in the upper mantle. Sound waves are P waves. The P stands for primary; it is so named because it is the *first arrival*. Syn: *longitudinal wave*; *irrotational wave*; *pressure wave*; *dilatational wave*; *primary wave*; *compressional wave*. Cf: *S wave*; *surface wave*.

**pycnocline** (pyc'-no-cline) 1. A density gradient; esp. a vertical gradient marking a sharp change. Cf: *thermocline*. 2. A layer of water in the ocean, characterized by a rapid change of density with depth.

**pygidium** (py-gid'-i-um) A tail or terminal body region of various invertebrates; esp. the posterior part or tail piece of the exoskeleton of a trilobite, consisting of several fused segments. Pl: *pygidia*. Adj: *pygidial*.

**pyramid** (pyr'-a-mid) An open crystal form consisting of three, four, six, eight, or twelve nonparallel faces that meet at a point. Cf: *dipyramid*.

**pyrargyrite** (pyr-ar'-gy-rite) A dark-red, gray, or black rhombohedral mineral,  $\text{Ag}_3\text{SbS}_3$ . It is an important ore of silver.

**pyribole** (pyr'-i-bole) A mnemonic term to indicate the presence of either or both a pyroxene and/or an amphibole. Etymol: *pyroxene* + *amphibole*.

**pyrite** (py'-rite) A common yellow isometric mineral,  $\text{FeS}_2$ . It is dimorphous with marcasite, and often contains small amounts of

other metals. Pyrite has a brilliant metallic luster and an absence of cleavage, and has been mistaken for gold (which is softer and heavier). It commonly crystallizes in cubes, octahedrons, or pyritohedrons. Pyrite is the most widespread and abundant of the sulfide minerals and occurs in all kinds of rocks. It is an important ore of sulfur, less so of iron, and is burned in making sulfur dioxide and sulfuric acid, it is sometimes mined for the associated gold and copper Cf: *pyrites*. Syn *fool's gold*

**pyrites** (py-n'-tes) Any of various metallic-looking sulfides, of which pyrite ("iron pyrites") is the commonest. The term is used with a qualifying term that indicates the component metal; e.g. "copper pyrites" (chalcopyrite). When used popularly and without qualification, the term usually signifies *pyrite*.

**pyritohedron** (py'-ri-to-he'-dron) In the isometric system, a crystal form consisting of twelve five-sided faces, each parallel to one axis and cutting the other two at unequal distances. Syn *pentagonal dodecahedron*.

**pyroclast** (py'-ro-clast) An individual particle ejected during a volcanic eruption. It is usually classified according to size.

**pyroclastic** (py-ro-clas'-tic) Pertaining to clastic rock material formed by volcanic explosion or aerial expulsion from a volcanic vent; also, pertaining to rock texture of explosive origin. It is not

synonymous with the adjective "volcanic".—In the plural, the term is used as a noun.

**pyroclastic rock** Any rock consisting of unworked solid material of whatever size explosively or aerially ejected from a volcanic vent. Syn: *fragmental rock*.

**pyrogenesis** (py-ro-gen'-e-sis) A broad term encompassing the intrusion and extrusion of magma and its derivatives. Adj: *pyrogenic*.

**pyrogenetic mineral** (py'-ro-genet'-ic) 1 An anhydrous mineral of an igneous rock usually crystallized at high temperature in a magma containing relatively few volatile components. 2 Any mineral crystallized directly from a magma, as distinct from minerals formed by alteration or replacement.

**pyrolusite** (py-ro-lu'-site) A soft iron-black or dark steel-gray tetragonal mineral,  $MnO_2$ . It is the most important ore of manganese. Pyrolusite is generally massive or reniform, sometimes with a fibrous or radiate structure.

**pyrometamorphism** (py'-ro-met'-a-mor'-phism) Local, intense metamorphism resulting from unusually high temperatures at the contact of a rock with a magma.

**pyrometasomatic** (py'-ro-met'-a-so-mat'-ic) Formed by metasomatic changes in rocks, principally in limestone, at or near intrusive contacts, under influence of magmatic emanations and high



temperature and pressure.

**pyrometasomatism** (py'-ro-met'-a-som'-a-tism) The formation of contact-metamorphic mineral deposits at high temperatures by emanations issuing from the intrusive and involving replacement of enclosing rock with addition or subtraction of materials; *skarn* formation. See also: *metasomatism*.

**pyrometer** (py-rom'-e-ter) An instrument that measures high temperature, e.g. of molten lavas, by electrical or optical means. See also: *optical pyrometer*.

**pyrope** (py'-rope) The magnesium-aluminum end-member of the garnet group, characterized by a deep fiery-red color:  $(Mg, Fe)_3Al_2(SiO_4)_3$ . It rarely occurs in crystals, but is found in detrital deposits as rounded and angular fragments, or associated with olivine and serpentine in basic igneous rocks such as kimberlite.

**pyrophyllite** (py-roph'-yl-lite) A white, gray, or brown mineral,  $AlSi_2O_5(OH)$ . It resembles talc and occurs in a foliated form or in compact masses in quartz veins, granites, and esp. metamorphic rocks.

**pyroxene** (py'-rox-ene) A group of common rock-forming minerals with the general formula  $ABSi_2O_6$ , where A is chiefly Mg,  $Fe^{+2}$ , Ca or Na, and B is Mg,  $Fe^{+2}$ , or Al. Pyroxene is characterized by short, stout crystals and good prismatic cleavage in two directions intersecting at angles of

about  $87^\circ$  and  $93^\circ$ . Mineral members of the group are the enstatite-hypersthene-ferrosilite series, the diopside-hedenbergite series, augite, pigeonite, acmite, and jadeite. Cf: *clinopyroxene*.

**pyroxene-hornfels facies** The set of metamorphic mineral assemblages in which basic rocks are represented by diopside + hypersthene + plagioclase, with amphibole typically absent. The facies is typical of high-grade thermal metamorphism, as in the inner parts of contact aureoles. It corresponds to temperatures higher than about  $550^\circ C$ , and to relatively low pressure. Cf: *granulite facies*.

**pyroxenite** (py-rox'-e-nite) An ultramafic plutonic rock chiefly composed of pyroxene, with accessory hornblende, biotite, or olivine.

**pyroxenoid** (py-rox'-e-noid) Any mineral chemically analogous to pyroxene, but with the  $SiO_4$  tetrahedra connected in chains with a repeat unit of 3, 5, 7, or 9; e.g. wollastonite and rhodonite.

**pyrrhotite** (pyr'-rho-tite) A common red-brown to bronze pseudo-hexagonal mineral,  $Fe_{1-x}S$ . It has a defect structure in which some of the ferrous ions are lacking. Some pyrrhotite is magnetic. The mineral is darker and softer than pyrite; it is usually found massive and commonly associated with pentlandite, often containing as much as 5% nickel, in which case it is mined as an ore of nickel.

## Q

**Q** A measure of loss of energy by absorption *Q* expresses the fraction of energy lost per stress cycle thus  $\Delta E/E = 2\pi/Q$  The dimensionless parameter *Q* is much used to describe the intrinsic attenuation of seismic waves

**quaquaversal** (qua-qua-ver'-sal)

adj Said of strata and structures that dip outward in all directions from a central point The term has also been used as a syn of *perichlinal* - n A geologic structure, such as a dome, having a quaquaversal dip Cf *pericline*

**quarry** Open workings, usually for the extraction of stone

**quarrying** (quar'-ry-ing) 1 *plucking* 2 The extraction of stone or other valuable nonmetallic material from a quarry

**quartz** Crystalline silica, an important rock-forming mineral,  $\text{SiO}_2$  It is, next to feldspar, the commonest mineral, occurring either in transparent hexagonal crystals or in crystalline or cryptocrystalline masses Quartz is the commonest gangue mineral of ore deposits, forms the major proportion of most sands, and has a widespread distribution in igneous (esp granitic), metamorphic, and sedimentary rocks It has a vitreous to greasy luster, a conchoidal fracture, an absence of cleavage and a hardness of 7 on the Mohs scale Cf *tridymite*, *cristobalite*, *coesite*, *stishovite* See also *amethyst*, *aventurine* ci-

*trine*

**quartzarenite** (quartz-ar'-e-nite) A sandstone that is composed primarily of quartz, specif. one containing more than 95% quartz grains The term is essentially equivalent to *orthoquartzite*.

**quartz crystal** Quartz that is transparent or nearly so, is usually colorless, and has a low refractive index resulting in low brilliance It is used for lenses, wedges, and prisms in optical instruments and for frequency control in electronics, or is fashioned into beads or other ornamental objects Syn *rock crystal*.

**quartz diorite** A group of plutonic rocks having the composition of *diorite* but with an appreciable amount of quartz, i.e. between 5 and 20 percent of the light-colored constituents, also, any rock in that group, the approximate intrusive equivalent of *dacite* Quartz diorite grades into *granodiorite* as the alkali feldspar content increases Syn *tonalite*

**quartz index** 1 A derived quantity in the Niggli system of rock classification, which may be either positive or negative, and is an indicator of a rock's degree of silica saturation. 2 A measure of the mineralogical maturity of a sandstone It is expressed as the ratio of quartz plus chert to the combined percentage of feldspar, rock fragments, and clay matrix It is used as a basis for evaluating the degree of weathering of the source rock and the degree to which the sediment has been transported

**quartzite** (quartz'-ite) 1 A granuloblastic metamorphic rock consisting mainly of quartz, formed by recrystallization of sandstone by regional or thermal metamorphism, a *metaquartzite* 2 A sandstone consisting of quartz grains cemented by secondary silica an *orthoquartzite*

**quartz monzonite** A granitic rock in which quartz comprises 10-50% of the felsic constituents, and in which the alkali feldspar/total feldspar ratio is between 35% and 65%, the approximate intrusive equivalent of *rhyncholite*. With an increase in plagioclase and feldspar minerals, it grades into *granodiorite* and with more alkali feldspar, into a *granite*. Syn *adamellite*

**quartzose** (quartz'-ose) Containing quartz as a principal constituent esp. applied to sediments and sedimentary rocks (such as sands and sandstones) consisting chiefly of quartz

**quartz porphyry** A porphyritic extrusive or hypabyssal rock containing phenocrysts of quartz and alkali feldspar in a microcrystalline or cryptocrystalline groundmass, a *rhyncholite*. Cf. *granite porphyry*

**quartz wedge** An elongate wedge of clear quartz that is used in the analysis of a mineral's fast and slow vibrational directions under the polarizing microscope

**Quaternary** (Qua-ter'-na-ry) The second period of the Cenozoic

era, following the Tertiary, also, the corresponding system of rocks. It began two to three million years ago and extends to the present. It consists of two grossly unequal epochs, the Pleistocene up to about 8,000 years ago and the Holocene since that time. The Quaternary may also be incorporated into the Neogene when the Neogene is designated as a period of the Tertiary era.

**quaternary system** A chronostratigraphic system having four principal components

**quebrada** (que-brá'-da) A term used in the southwestern U.S. for a ravine or gorge, esp. one that is usually dry but is filled by a torrent during a rain. Etymol. Spanish

**quicksand** A mass or bed of fine sand that consists of smooth rounded grains with little tendency to mutual adherence and that is usually saturated with water flowing upward through the voids forming a soft shifting, semiliquid highly mobile mass that yields easily to pressure and tends to suck down and swallow heavy objects resting on or touching its surface

**quicksilver** A term applied to *mercury* where it occurs as a native mineral or has been mined but not yet used (as in "flasks of quicksilver")

**Q wave** Love wave

## R

**race** 1 A strong current of water flowing through a narrow channel, e.g. a tide race, also, the constricted channel in which such a current flows. 2 A group of organisms with similar characteristics but not distinctive enough to be classified as a species or subspecies.

**radar** An electronic detection device for locating or tracking a distant object by measuring elapsed time of travel of ultrahigh-frequency radio waves emitted from a transmitter and reflected back by the object in such a way that range, bearing, height and other characteristics of the object may be determined. Radar operation is unaffected by darkness, but moisture in the form of fog, snow, rain, or heavy clouds may cause attenuation or reflection of the radio energy. Etymology: radio + detecting and ranging.

**radial drainage pattern** (ra-di-al) An arrangement of surface drainage in which streams radiate, like the spokes of a wheel, from a high central area, e.g. a volcanic cone.

**radial fault** One of a group of faults that radiate from a central point.

**radial symmetry** The property possessed by an organism of having similar parts regularly arranged about a central point or axis, as in a starfish or flower.

**radiation** (ra-di-a'tion) 1 The emission of atomic particles or

rays from the nucleus of an atom. See *radioactivity*. 2 The dispersal of a group of organisms into different environments, accompanied by divergent change in the evolutionary structure.

**radiation damage** The damage done to a crystal lattice (or glass) by passage of fission particles or alpha particles from the nuclear decay of a radioactive element residing in the lattice. The damage paths can be enlarged to microscopic size by suitable etching techniques and used to determine an age for the material.

**radioactive age determination** (ra-di-o-ac-tive) *radiometric dating*.

**radioactive clock** A radioactive isotope, e.g. carbon 14 or potassium-40, whose decay constant is known and is low enough to be calibrated to time units, usually years. Radioactive clocks are the basis of absolute-age determinations and the specific element being used is sometimes designated as a clock, e.g. carbon clock.

**radioactive decay** The spontaneous disintegration of the atoms of certain *nuclides* into new nuclides, which may be stable or undergo further decay until a stable nuclide is finally created. Radioactive decay involves the emission of alpha particles and beta particles, and usually is accompanied by emission of *gamma rays*. It always results in the generation of heat. Cf. *radioactivity*.

**radioactive element** An element capable of changing spontaneously into another element by the

emission of charged particles from the nuclei of its atoms. For some elements, e.g. uranium, all known isotopes are radioactive; for others, e.g. potassium, only one of several isotopes is radioactive. Radioactive isotopes of most elements can be prepared artificially, only a few elements are naturally radioactive.

**radioactive series** A series or succession of *nuclides*, each of which becomes the next by radioactive decay, until a stable nuclide is formed. There are three important natural radioactive series, the actinium series, thorium series, and uranium series. See also: *parent; daughter; end product*

**radioactivity** (ra'-di-o-ac-tiv'-i-ty)

1 The emission of energetic particles and/or radiation during *radioactive decay*. 2 A particular radiation component from a radioactive source, such as gamma radioactivity.—Adj. radioactive.

**radioactivity log** The generic name for well logs whose curves derive from reactions of atomic nuclei involving the behavior of gamma rays and/or neutrons. Except for the natural *gamma-ray log* and the *spectral gamma-ray log*, they record the response of rocks very near the well bore to bombardment by gamma rays or neutrons from a source in the logging *sonde*. Most can be obtained in cased, empty, or fluid-filled well bores. See also: *density log; neutron log; neutron-activation log*.

Syn: *nuclear log*.

**radiocarbon dating** (ra'-di-o-car'-hon) *carbon-14 dating*.

**radiogenic** (ra'-di-o-gen'-ic) Said of a product of a radioactive process, e.g. heat, lead.

**radiogenic isotope** An isotope that was produced by radioactive decay, but which itself may or may not be radioactive. See also: *radioisotope*.

**radioisotope** (ra'-di-o-i'-so-to-pe) A radioactive isotope of an element. See also: *radiogenic isotope*.

**radiolarian** (ra'-di-o-lar'-i-an) Any actinopod belonging to the subclass Radiolaria, characterized mainly by a siliceous skeleton and a marine pelagic environment. Range, Cambrian to present.

**radiolarian ooze** A deep-sea pelagic sediment containing at least 30% opaline-silica tests of radiolarians. It is a *siliceous ooze*.

**radiometric dating** (ra'-di-o-met'-ric) Calculating an age in years for geologic materials by measuring the presence of a short-life radioactive element, e.g. carbon-14, or a long-life radioactive element plus its decay product, e.g. potassium-40/argon-40. The term applies to all methods of age determination based on nuclear decay of naturally occurring radioactive isotopes. Syn: *radioactive age determination*.

**rafting** Transportation of rocks or soil by means of attachment to ice, plants, or other floating material.

**rain shadow** A very dry region on the lee side of a topographic ob-

**str 1** Usually a mountain range where the rainfall is noticeably less than on the windward side. The White Mountains in east central California are in the rain shadow of the Sierra Nevada.

**rainwash 1** The washing away of loose surface material by rainwater before it has been concentrated into definite streams. *sheet erosion*. Also the movement downslope (under the action of gravity) of material loosened by rainwater. It occurs esp in semiarid or scantily vegetated regions. **2** The rainwater involved in the process of rainwash or the material that results from it.

**raise** A mine shaft driven upward from a lower to a higher level.

**raised beach** An ancient beach occurring above the present shore line, having been elevated either by local uplift of the land or by lowering of sea level. Cf *marine terrace*. See also *strandline*.

**raised reef** An organic reef standing above sea level.

**rake pitch**

**ramp 1** The steepened segment of a thrust fault esp where a bedding thrust or decollement changes from a stratigraphically lower to a higher bed. **2** A drift of snow that forms an inclined plane between land or land ice and sea or shelf ice.

**ramp anticline** An anticline formed in a thrust sheet as a result of movement up a *ramp*.

**rampart 1** A narrow ridge 1-2 m high, built by waves along the seaward edge of a reef flat, consisting

of reef rubble commonly capped by dune sand. **2** *lake rampart*. **3** A crescentic or ringlike ridge of pyroclastics around the top of a volcano.

**ramp valley** A valley that is bounded by high-angle thrust faults.

**range 1** *mountain range*. **2** The numerical difference between the highest and lowest values in any series e.g. between the largest and smallest particle sizes of a sediment or sedimentary rock. **3** *stratigraphic range*. **4** The geographic area over which an organism or group of organisms is distributed. **5** An area in which a mineral bearing formation crops out e.g. the "iron range" of the Lake Superior region; a mineral belt. **6** Any series of contiguous

*townships* of the U.S. Public Land Survey system, aligned north and south and numbered consecutively east and west from a *principal meridian* to which it is parallel.

**range finder** An instrument for finding the distance from a single point of observation to other points at which no instruments are placed.

**range line** One of the imaginary boundary lines running north and south at six-mile intervals and marking the relative east and west locations of townships in a U.S. public-land survey, a meridional township boundary line. Cf *township line*.

**range-zone** A body of strata representing the total range of occurrence of any selected element of

the assemblage of fossil forms in a stratigraphic sequence. The word "range" implies extent in both horizontal and vertical directions.

Cf: *biozone*; *acme-zone*.

**rank** 1. The degree of metamorphism in coal. It is the basis of coal classification into a natural series from lignite to anthracite. Cf: *grade*; *type*. 2. *metamorphic grade*.

**rapakivi texture** (ra-pa-ki'-vi) A texture originally described from Finnish granites. In typical specimens, flesh-colored potassic feldspar occurs as rounded crystals a few centimeters in diameter that are mantled with sodic plagioclase.

**rapids** (rap'-ids) A part of a stream where the current is moving swiftly and where the water surface is broken by obstructions, as where the stream descends over a series of small steps. See also: *cascade*; *cataract*.

**rare earths** Oxides of a series of fifteen metallic elements, from lanthanum (atomic number 57) to lutetium (71), and of three other elements: yttrium, thorium, and scandium. These elements are not especially rare in the earth's crust, but concentrations are. The rare earths are constituents of certain minerals, esp. monazite, bastnaesite, and xenotime. Abbrev: REO.

**rational face** (ra'-tion-al) A crystal face naturally suggested by and peculiar to the internal molecular structure of the mineral species to which the crystal belongs.

**ravine** (ra-vine') A small valley,

usually carved by running water; esp. the narrow excavated valley of a mountain stream. Etymol: French, "mountain torrent".

**ray** 1. A vector normal to a wave surface, indicating the direction and sometimes the velocity of propagation. 2. One of the long, bright streaks or lines observed on the moon's surface and appearing to radiate from a lunar crater, in some instances for hundreds of kilometers. 3. Any of the radiating divisions of the body of an echinoderm, together with all structures borne by it. 4. In the bony fishes, one of the fine rods that support a fin.

**Rayleigh wave** A type of surface wave having a retrograde, elliptical motion at the free surface. See also: *Rg wave*. Syn: *R wave*.

**raypath** The imaginary line along which wave energy travels. A raypath is always perpendicular to the wave front in isotropic media. Syn: *path*.

**reach** 1. The length of a stream channel that is uniform with respect to discharge, depth, area, and slope, also. the length of a stream between two specified gaging stations, or a straight stretch between two bends. 2. An arm of the sea extending into the land, e.g. an estuary. 3. A continuous or unbroken expanse of water or land.

**reaction boundary** (re-ac'-tion) *reaction line*.

**reaction curve** *reaction line*.

**reaction line** In a ternary system, a boundary line along which one of

the two crystalline phases reacts with the liquid, as the temperature is decreased, to form the other crystalline phase. Syn: *reaction boundary*; *reaction curve*.

**reaction pair** Any two minerals, one of which is formed at the expense of the other by reaction with liquid; esp. any two adjacent minerals in a *reaction series*.

**reaction point** A point on a *liquidus* diagram in which the composition of the liquid cannot be stated in terms of position quantities of all the solid phases in equilibrium at the point. In a binary system it is equivalent to an incongruent melting point.

**reaction principle** The concept of a *reaction series*.

**reaction rim** A peripheral zone around a mineral, it is composed of another mineral species and represents the reaction of the earlier solidified mineral with the surrounding magma. Cf. *corrosion border*; *corona*.

**reaction series** A series of minerals in which any early-formed mineral phase tends to react with the melt, later in the differentiation, to yield a new mineral further down in the series, e.g. early-formed crystals of olivine react with later liquids to form pyroxene crystals, and these in turn may react with still later liquids to form amphiboles. Cf. *continuous reaction series*; *discontinuous reaction series*. This concept is frequently referred to as *Bowen's reaction series*, after N. L. Bowen, who first proposed it, or as the

*reaction principle*. See also: *reaction pair*.

**realgar** (re-al'-gar) A bright-red to orange-red monoclinic mineral, As<sub>2</sub>S<sub>3</sub>. It occurs as nodules in ore veins and as a massive or granular deposit from some hot springs, and it is frequently associated with orpiment.

**recapitulation theory** (re'-ca-pit'-u-la'-tion) A theory in biology stating that an organism passes through successive stages resembling its ancestors, so that the *ontogeny* of the individual is a recapitulation of the *phylogeny* of its group. See also *palingenesis*. Syn: *Haeckel's law*.

**Recent Holocene**

**recess** 1 That part of an orogenic belt in which the axial traces of the folds are concave toward the outer part of the belt. Ant. *salient*. 2 An indentation in a surface, e.g. a cleft in a steep rock face. - See also *reentrant*.

**recession** (re-ces'-sion) 1 *glacial recession*. 2 The backward movement or retreat of an eroded escarpment, or the moving-back of a slope from a former position without a change in its angle. 3 A continuing landward movement of a shoreline undergoing erosion; also, a net landward movement during a specified period of time. Ant. *advance*.

**recessional moraine** (re-ces'-sion-al) An end or lateral moraine built during a pause in the final retreat of a glacier. Also, a moraine built during a slight or minor readvance of the ice front during a



period of general recession Syn *stadial moraine*

**recharge** The processes involved in the addition of water to the zone of saturation, also, the amount of water added Syn *intake*

**reconnaissance** (re-con'-nais-sance) A general, exploratory examination or survey of the main features of a region, usually preliminary to a more detailed survey. It may be made in the field or office, depending on the extent of information available

**recovery** (re-cov'-er-y) 1 In mining the percentage of valuable material derived from an ore, or of coal from a coal seam a measure of mining efficiency 2 The rise in static water level in a well that occurs when discharge from that well or a nearby well is stopped 3 In structural petrology any process through which the number of grain dislocations (strain energy) produced during rock deformation can be reduced e.g. recrystallization, by which new strain-free material is formed 4 A visit to a survey station to identify its mark or monument as authentic and in its original location and to verify or revise its description

**recovery factor** A measure of the percentage of oil in place that can be recovered, it depends on porosity, permeability, type of reservoir energy, and past experience under similar conditions

**recrystallization** (re-crys'-tal-li-za'-tion) The formation, essentially in the solid state, of new crys-

talline mineral grains in a rock. It is the way in which a deformed crystal aggregate releases stored strain energy due to deformation. The new grains are generally larger than the original grains, and may have the same or a different mineralogical composition. See also *grain growth*, *Riecke's principle*

**rectangular drainage pattern** (rect-an-gu-lar) An arrangement of surface drainage in which the main streams and their tributaries display right-angle bends and exhibit sections of approximately the same length, it is indicative of streams following prominent fault or joint systems that break the rocks into rectangular blocks. Examples are well developed along the Norwegian coast and in parts of the Adirondack Mountains. See also *trellis drainage pattern*

**recumbent fold** (re-cum-bent) An overturned fold in which the axial surface is more or less horizontal

**recurved spit** A spit whose outer end is turned landward by current deflection, by the opposing action of two or more currents, or by wave refraction, a *hook*

**red beds** Sedimentary strata composed largely of sandstone, silt stone, and shale, that are predominantly red due to the presence of ferric oxide (hematite) coating individual grains, e.g. the Permian and Triassic sedimentary rocks of western U.S., and the Old Red Sandstone facies of the European Devonian. Also spelled *redbeds*.

**red clay** A pelagic deposit that is fine-grained and reddish brown or chocolate-colored, formed by the slow accumulation of material a long distance from the continents and at depths generally greater than 3500 meters. It contains relatively large proportions of windblown particles, meteoric and volcanic dust, pumice, shark teeth, whale carbones, manganese nodules, and debris rafted by ice.

**red mud** 1. A type of marine mud that is land-derived and contains as much as 25% calcium carbonate. Its color is due to the presence of ferric oxide. 2. The residue in waste ponds and pits from bauxite processing for aluminum production.

**red ocher** A red, earthy hematite, used as a pigment. See also *ocher*.

**red tide** A type of *plankton bloom*, caused by dinoflagellates, that locally colors coastal waters red.

**reducing flame** In blowpiping, the blue part of the flame, in which oxygen in the compound being tested is partly burned away. Cf. *oxidizing flame*.

**reduction** (re-duc'-tion) 1. Application of free-air or other corrections to gravity measurements. 2. The lowering of a land surface by erosion. 3. The removal of oxygen from a compound, e.g. from hematite to produce metallic iron.

**reduction index** The rate of wear of a sedimentary particle subject to abrasion in the course of transportation. Cf. *durability index*.

**reduzates** (re-du'-zates) Sediments

accumulated under reducing conditions and thus characteristically rich in organic carbon and iron sulphide; coal and black shale are principal examples. Cf. *resistates*; *evaporates*; *hydrolyzates*; *oxidates*.

**reef** 1. A ridge-like or mound-like structure, layered or massive, built by sedentary calcareous organisms, esp. corals, and consisting mostly of their remains; it is wave-resistant and stands above the surrounding contemporaneously deposited sediment. Also, such a structure built in the geologic past and now enclosed in rock, commonly of differing lithology. See also *bank*; *bioherm*; *biostrome*. Syn. *organic reef*. 2. A mass or ridge of rocks, esp. coral and sometimes sand, gravel, or shells, rising above the sea or lake bottom to or nearly to the surface, and dangerous to navigation. See also: *shoal*. 3. A provincial term for an ore deposit, esp. gold-bearing quartz (e.g. *saddle reef*).

**reef breccia** A rock formed by the consolidation of limestone fragments broken off from a reef by the action of waves and tides.

**reef complex** A solid reef and the fragmentary material derived from it by abrasion, the aggregate of reef, fore-reef, back-reef, and interreef deposits, bounded on the seaward side by basin sediments and on the landward side by lagoonal sediments.

**reef core** Within a reef, the centrally located solid rock mass constructed in place by reef-building organisms; the solid reef proper.

**reef flank** The part of a reef that surrounds, interfingers with, and locally overlies the *reef core*, often indicated by beds of detritus dipping away from the core. It is the relatively narrow zone where the biologic forces of reef expansion contend with the physical and biologic forces of reef destruction.

**reef flat** A stony platform of dead reef-rock, commonly strewn with coral fragments and coral sand, generally dry at low tide and formed as the summit of the reef above low tide.

**reef knoll** 1. A fossil coral reef now represented by a small, prominent hill, up to 100 m high; specif. a conical mass of coralline limestone, more or less circular in ground plan and commonly surrounded by rock of different lithology, as in the type area, the Craven district in Yorkshire, England. 2. A present-day reef in the form of a knoll.

**reef patch** A growth of coral formed independently on a shelf of less than 70 m depth, often in the lagoon of a barrier reef or atoll, ranging from an expanse several kilometers across down to that of a single large colony. See also: *reef knoll*; *shoal reef*. Cf: *patch reef*.

**reef rock** A resistant massive unstratified rock consisting of the calcareous remains of reef-building organisms, often intermingled with carbonate sand and shingle, the whole cemented by calcium carbonate. Cf: *biolithite*.

**reentrant (re-en'-trant)** adj. Reentering or directed inward; e.g. a reentrant angle in a coastline or on a twinned crystal.—n. A prominent, generally angular indentation in a landform; e.g. an inlet between promontories along a coastline. Also spelled: *re-entrant*. Ant: *salient*. See also: *recess*.

**reference locality (ref'-er-ence)** A locality containing a reference section, established to supplement the *type locality*.

**reference plane datum plane.**

**reference section** A rock section designated to supplement the *type section*, or to supplant it if it is no longer exposed, and to afford a standard for correlation for a certain part of the geologic column; e.g. an auxiliary section of particular regional or facies significance. See also: *standard section*.

**reflectance (re-flec'-tance)** The ratio of the energy reflected by a body to that incident upon it.

**reflected wave** A seismic wave that has been reflected at an interface between media with different elastic properties. Cf: *converted wave*.

**reflection (re-flec'-tion)** The return of a wave incident upon a surface to its original medium. See also: *law of reflection*; *total reflection*. Also, in seismic prospecting, the indication on a record of such reflected energy. Cf: *refraction*; *diffraction*.

**reflection coefficient** The ratio of the amplitude of the reflected wave to that of the incident wave. The ratio of the reflected energy

to the incident energy is the reflection coefficient squared

**reflection shooting** A type of seismic survey based on measurement of the travel times of waves that originate from an artificially produced disturbance and are reflected back at near-vertical incidence from subsurface boundaries separating media of different elastic-wave velocities Cf *refraction shooting*

**reflux** A return flow, especially the return flow of concentrated brine through the floor or across the barrier sill of an evaporite basin. Because such brines may be enriched in magnesium compared to seawater, reflux is believed to contribute to the dolomitization of carbonate rocks in some basinal sequences

**refraction** (re-frac'tion) The deflection of a ray of light or of an energy wave (such as a seismic wave) due to its passage from one medium to another of differing density which changes its velocity Cf *reflection diffraction*. See also *birefringence*

**refraction shooting** A type of seismic survey based on the measurement of the travel times of seismic waves that have moved nearly parallel to the bedding in high-velocity layers, in order to map such layers Cf *reflection shooting*

**refractometer** (re-frac-tom'e-ter) An apparatus for determining the index of refraction of a substance, either solid or liquid

**refractory** (re-frac'-to-ry) adj 1

Said of an ore from which it is difficult to recover the valuable constituents 2 Said of a substance that is notably resistant to heat —n A material resistant to heat The term is often used in the plural

**refractory ore** Ore difficult to treat for recovery of the valuable substances

**regelation** (re-ge-la'-tion) A twofold process involving the melting of ice under excess pressure and the refreezing of the derived melt water upon release of that pressure

**regenerated crystal** (re-gen' er- at-ed) A large crystal that has grown in a mass of crushed material such as mylonite

**regime** (re-gime') 1 A regular or systematic pattern of occurrence or action, or a condition having widespread influence as a sedimentation regime 2 The existence in a stream channel of a balance or grade between erosion and deposition over a period of years 3 The condition of a stream with respect to the rate of its average flow as measured by the volume of water passing different cross sections in a specified period of time 4 In glaciology, a syn of *balance*

**regimen** (reg'-i-men) 1 The flow characteristics of a stream, e.g. velocity, volume, changes in channel, and capacity to transport sediment Cf *regime* 2 The total quantity of water involved in a drainage basin and its behavior, determined by measur-

ing such quantities as rainfall, surface and subsurface storage and flow, and evapotranspiration

3. An analysis of the total quantity of water involved with a lake over a specified period of time, usually a year. 4. *Glacial balance*  
**regional dip** (re'-gion-al) The nearly uniform inclination of strata over a wide area, generally at a low angle, as in the Atlantic and Gulf coastal plains and parts of the Midcontinent region Cf *homocline* Syn *normal dip*

**regional metamorphism** A general term for metamorphism affecting an extensive region, as opposed to *local metamorphism*. It is used almost synonymously with *dynamothermal metamorphism*. Cf *dynamic metamorphism*

**regional unconformity** An unconformity that extends continuously throughout an extensive region. It may be nearly continent-wide and usually represents a relatively long period

**regolith** (reg'-o-lith) The fragmental and unconsolidated rock material, whether residual or transported, that nearly everywhere forms the surface of the land and overlies the bedrock. It includes rock debris of all kinds—volcanic ash, glacial drift, alluvium, loess, vegetal accumulations, and soil. Etymol. Greek *rhegos*, "blanket", + *lithos*, "stone". See also: *lunar regolith*. Syn *mantle*; *mantle rock*; *rock mantle*; *overburden*.

**regression** (re-gres'-sion) 1. Retreat of the sea from land areas,

also, any change that converts offshore, deep-water conditions to nearshore, shallow-water conditions, or that moves the boundary between marine and nonmarine deposition toward the center of a marine basin. Ant: *transgression*.

2. The trend exhibited by offspring, in respect to their inherited characteristics, away from advanced characters shown by their parents and toward a simpler state

**regressive overlap** (re-gres'-sive) *offlap*

**regressive reef** One of a series of nearshore reefs or bioherms superimposed on basinal deposits during the rising of a landmass or the lowering of the sea level, and developed more or less parallel to the shore Cf *transgressive reef*  
**regressive sediments** Sediments deposited during the retreat or withdrawal of water from a land area or during the emergence of the land, and characterized by an *offlap* arrangement

**rejuvenated stream** (re-ju'-ve-nat'-ed) A stream that, after having developed to maturity or old age, has had its erosive ability renewed as a result of regional uplift or other cause of rejuvenation. It may be characterized by entrenched meanders, stream terraces, and meander cusps

**rejuvenation** (re-ju'-ve-na'-tion) 1. The action of stimulating a stream to renewed erosive activity, as by uplift or by a drop of sea level, the restoration of youthful vigor to a stream that has attained

maturity or old age 2 The development of youthful features in an area previously worn down nearly to base level, a change in conditions, leading to the start of a new cycle of erosion 3 The renewal of any geologic process, such as the reactivation of a fissure

**relative abundance** (rel'-a-tive) The number of individuals of a taxon in comparison with the number of individuals of other taxa in a certain area or volume See also *abundance*

**relative age** The geologic age of a fossil, rock, geologic feature, or event, defined relative to other fossils, rocks, features, or events rather than in terms of years Cf *absolute age*

**relative dating** The chronological ordering of features, fossils, or events with respect to the geologic time scale without reference to their absolute age

**relative humidity** The ratio, expressed as a percentage of the actual amount of water vapor in a given volume of air to the amount that would be present if the air were saturated at the same temperature Cf *absolute humidity*

**relative permeability** The ratio between the *effective permeability* to a given fluid at a partial saturation and the permeability at 100% saturation (the *absolute permeability*) It ranges from zero at a low saturation to 1.0 at a saturation of 100%

**release joint sheeting**

**relic** (rel'-ic) 1 A landform that has survived decay or disintegra-

tion, such as an erosion remnant 2 A metamorphic *relict* 3 A vestige of a particle in a sedimentary rock, such as a trace of skeletal material in a carbonate rock

**relict** (rel'-ict) 1 adj Said of a topographic feature that remains after other parts have disappeared, e.g. a "relict beach ridge" Cf *relic* Syn *residual* —n A relict landform 2 adj Pertaining to a mineral or structure of an earlier rock that has persisted in a later rock in spite of metamorphism —n Such a mineral or structure Cf *palimpsest* 3 adj Said of a remnant of an otherwise extinct group of organisms —n A remnant of such a group

**relict permafrost** Permafrost that was formed in the past and persists in places where it could not form today

**relict texture** In mineral deposits an original texture that remains after partial or total replacement

**relief** 1 The physical configuration of a part of the earth's surface, with reference to variations of height and slope or to irregularities of the land surface the elevations or differences in elevation, considered collectively, of a surface 2 The vertical difference in elevation between the summits and the lowlands of a given region A rough country has "high relief" and a flat country "low relief" 3 The range of values over a geophysical anomaly or within an area, e.g. the "gravity relief" for the magnitude of a gravity anomaly 4 An apparent-

ly rough surface of a crystal section under the microscope. High relief indicates a great difference in *index of refraction* between the crystal and its mounting medium. The relief is positive if the refractive index of the mineral is greater than that of the medium, and negative if the reverse is true.

**relief map** A map that depicts the surface configuration or relief of an area by any method, e.g. contour lines and hachures, hill shading, or layer tinting.

**remanent magnetization** (rem'-a-nent) That component of a rock's magnetization that has a fixed direction relative to the rock and is independent of moderate, applied magnetic fields such as the earth's magnetic field Cf *induced magnetization*.

**remote sensing** The collection of information about an object by a recording device that is not in physical contact with it. The term is usually restricted to mean methods that record reflected or radiated electromagnetic energy, rather than methods that involve significant penetration into the earth. The technique employs such devices as the camera, infrared detectors, microwave frequency receivers, and radar systems.

**reniform** (ren'-i-form) Kidney-shaped. Said of a crystal structure in which radiating crystals terminate in rounded masses, also said of mineral deposits having a surface of rounded, kidneylike shapes Cf *colloform*, *botryoidal*.

**RFO** Abbrev. of "rare-earth ox-

ides", i.e. *rare earths*.

**replacement** 1. *metasomatism*. 2. A process of fossilization involving substitution of inorganic matter for the original organic constituents of a plant or animal.

**representative fraction** (rep-re-sent'-a-tive) The scale of a map, expressed in the form of a numerical fraction that relates linear distance on the map to the corresponding distance on the ground, measured in the same unit, e.g. "1/24,000" indicates that one unit on the map represents 24,000 equivalent units on the ground. Abbrev. RF.

**reptile** Any vertebrate of the class Reptilia, cold-blooded vertebrates that are air-breathing at all stages of development. Range, Pennsylvanian to present.

**resection** (re'-sec-tion) 1. A method in surveying by which the horizontal position of an occupied point is determined by drawing lines from the point to two or more points of known position. 2. A method of determining a plane-table position by orienting along a previously drawn foresight line and drawing one or more rays through the foresight from previously located stations.

**resedimentation** (re'-sed-i-men-ta'-tion) 1. Sedimentation of material derived from a pre-existing sedimentary rock, redeposition of sedimentary material. 2. Mechanical deposition of material in cavities of postdepositional age, such as the deposition of carbonate muds and silts by internal me-

chanical erosion or solution of a limestone 3 The general process of subaqueous, downslope movement of sediment under the influence of gravity, such as the formation of a turbidity-current deposit

**resequent fault-line scarp** (re'-se-quent) A *fault line scarp* that faces in the same direction as the original fault scarp, i.e. faces the downthrown block Cf. *obsequent fault line scarp*

**resequent stream** A stream that flows down the dip of underlying strata in the same direction as an original consequent stream but developed later at a lower level than the initial slope (as on formerly buried resistant strata) and is generally tributary to a subsequent stream e.g. a stream flowing down the back slope of a caesura

**reserves** *Identified resources* of mineral or fuel-bearing rock from which the mineral or fuel can be extracted profitably with existing technology and under present economic conditions The concept can be used in global, regional, or local senses, or applied as a measure of the remaining effective life of an individual mine See also *resources*

**reservoir** (res'-er-voir) 1 A subsurface volume of porous and permeable rock in which oil or gas has accumulated a *pool* 2 Subsurface rock or regolith that is saturated with water, an *aquifer* 3 A pond or lake, natural or artificial, from which water may be with-

drawn for irrigation or water supply

**reservoir energy** The energy or "drive" within an oil or gas pool See *dissolved-gas drive*, *gas-cap drive*, *water drive*

**reservoir gas-oil ratio** The number of cubic feet of gas per barrel of oil in the reservoir See also *gas-oil ratio*

**reservoir pressure** *bottom-hole pressure*

**reservoir rock** Any porous and permeable rock that yields oil or gas Sandstone, limestone, and dolomite are the most common types Syn *pay*

**residual** (re-sid'-u-al) 1 Said of a *relict* topographic feature 2 Said of a mineral deposit formed by mechanical concentration e.g. a placer or by decomposition in the zone of weathering, e.g. kaolin from feldspar 3 Pertaining to or constituting an accumulation of rock debris formed by weathering and remaining in place after all but the least soluble constituents have been removed, e.g. a residual clay 4 n In geophysics, that which is left after gross regional effects have been removed, in order to emphasize local anomalies — adj Said of such an anomaly or gradient, e.g. residual gravity

**residual clay** Clay material formed in place by the weathering of rock, derived either from the chemical decay of feldspar and other rock minerals or from the removal of nonclay-mineral constituents by solution from a clay-



bearing rock (such as an argillaceous limestone).

**residual gravity** The portion of a gravity effect remaining after removal of the gross "regional" effects; usually the relatively small or local anomaly components of the total or observed gravity field.

**residual liquid** The still-molten part of a magma that remains in the magma chamber after some crystallization has taken place during a series of differentiations. Syn: *residual magma*; *rest magma*, *ichor*.

**residual magma** *residual liquid*

**residual magnetism** The portion of a magnetic effect remaining after removal of the gross "regional" effects; usually the relatively small or local anomaly components of the total or observed magnetic field.

**residual soil** Soil formed in place by the decomposition of rocks like those on which it lies.

**resilience** (re-sil'i-ence) The ability of a material to store the energy of elastic strain. This ability is measured in terms of energy per unit volume.

**resin** Any of various hard, brittle, transparent or translucent substances formed esp. in plant secretions and obtained as exudates of recent or fossil origin by the condensation of fluids on the loss of volatile oils. Resins are yellowish to brown, with a characteristic luster; they are fusible and flammable, are soluble in ether and other organic solvents but not in

water. See also: *amber*.

**resinous luster** (res'-in-ous) The luster on the fractured surfaces of certain minerals (such as opal, sulfur, amber, and sphalerite) and rocks (such as pitchstone) that resembles the appearance of resin.

**resistates** (re-sis'-tates) Sediments composed of chemically resistant minerals, enriched in weathering residues; e.g. highly quartzose sediments characteristically rich also in zircon, ilmenite, rutile, and, more rarely, cassiterite, monazite, and gold. Cf: *hydrolyzates*; *oxidates*; *reduzates*; *evaporates*.

**resistivity** (re-sis-tiv'-i-ty) 1. *electrical resistivity*. 2. *thermal resistivity*.

**resistivity log** A well log consisting of one or more resistivity curves, which may be of various types. As a spontaneous-potential curve is commonly also present, the term resistivity log is often used as a syn. of *electric log*.

**resistivity method** Any electrical exploration method in which current is introduced into the ground by two contact electrodes and potential differences are measured between two or more other electrodes.

**resolution** (res-o-lu'-tion) A measure of the ability of geophysical instruments, or of remote-sensing systems, to define closely spaced targets.

**resorption** (re-sorp'-tion) The partial or complete re-fusion or solution, by and in a magma, of previously formed crystals or minerals

with which the magma, owing to changes of temperature, pressure, or chemical composition, has ceased to be in equilibrium.

**resources** (re-sourc'-es) *Reserves* plus all other mineral deposits that may eventually become available — either known deposits that are not recoverable at present, or unknown deposits, that may be inferred to exist but have not yet been discovered. They represent the mineral endowment, global, regional, or local, ultimately available for man's use. See also: *identified subeconomic resources*; *hypothetical resources*; *speculative resources*. Syn: *mineral resources*.

**rest magma** *residual liquid*.

**reurgence** (re-sur'-gence) The point where an underground stream appears at the surface to become a surface stream. Syn: *rise*; *emergence*; *debouchure*.

**retained water** Interstitial water held in the soil by molecular attraction against gravity, in isolated interstices, or as water vapor occupying interstices from which water has drained.

**reticulate** (re-tic'-u-late) 1. Said of a vein or lode with netlike structure, e.g. a *stockwork*. 2. Said of a rock texture in which crystals are partially altered to a secondary mineral, forming a network that encloses remnants of the original mineral. 3. Said of a netted pattern of an invertebrate, "e.g. a 'reticulate layer' on the surface of a foraminiferal test."

**grade)** A type of *polymetamorphism* by which minerals of a lower grade are formed at the expense of minerals characteristic of a higher grade, a readjustment necessitated by a change in physical conditions, e.g. lowering of temperature. Syn: *retrogressive metamorphism*.

**retrograding shoreline** (ret'-ro-grad-ing) A shoreline that is being extended landward by wave attack. Ant: *prograding shoreline*.

**retrogressive metamorphism** (ret-ro-gres'-sive) *retrograde metamorphism*.

**reversal** (re-ver'-sal) *geomagnetic reversal*.

**reversed polarity** 1. A natural remanent magnetization opposite to the present ambient geomagnetic-field direction. See also: *geomagnetic reversal*. 2. A configuration of the earth's magnetic field with the magnetic positive pole, where field lines leave the earth, located near the geographic north pole.—Cf: *normal polarity*.

**reversed zoning** *inverse zoning*.

**reverse fault** A fault along which the hanging wall has been raised relatively to the footwall. Cf: *normal fault*. Partial syn: *thrust fault*.

**reverse-flowage fold** A fold in which flow from deformation has thickened the anticlinal crests and thinned the synclinal troughs, contrary to the normal flow pattern of a *flow fold*.

**reverse similar fold** A fold in which the strata are thickened on

and trough, the reverse of the condition in a *similar fold*.

**revolution** (rev-o-lu'-tion) A term formerly popular among geologists for a time of profound orogeny and other crustal movements, on a continentwide or even world-wide scale, the assumption being that such revolutions produced abrupt changes in geography, climate, and environment. The basic premise of the concept is dubious, and the term revolution is little used today.

**reworked** Said of a sediment, fossil, rock fragment, or other geologic material that has been removed or displaced by natural agents from its place of origin and incorporated in recognizable form in a younger formation, such as a "reworked tuff" carried by flowing water and redeposited in another locality.

**RF** *representative fraction*.

**Rg wave** A slow, short period Rayleigh wave that travels only along a nonoceanic path. The 'g' refers to the granitic layer. Cf. *Lg wave*.

**rheid** (rhe'-id) A substance (below its melting point) which deforms by viscous flow during the time of applied stress at an order of magnitude at least three times that of elastic deformation under similar conditions.

**rheol fold** A fold which must have been deformed by flow. Cf. *flow fold*.

**rheology** (rhe'-ol-og-ee) The study of the deformation and flow of matter.

The process by which a rock becomes mobile as a result of at least partial fusion, commonly accompanied by, if not promoted by, addition of new material by diffusion. Cf. *mobilization*.

**rhizococretion** (rhi'-zo-con-cre'-tion) A small cylindrical or conical structure in a sedimentary rock, usually branching or forked, resembling a root of a tree. It may consist of material such as caliche or chert.

**rhodochrosite** (rho-d(ə)-chro-site) A rose-red or pink to gray rhombohedral mineral of the calcite group  $MnCO_3$ . It is isomorphous with calcite and siderite, and commonly contains some calcium and iron; it is a minor ore of manganese.

**rhodolite** (rho'-do-lite) A pink rose, or violet garnet, intermediate in chemical composition between pyrope and almandine. It has a light color and a high degree of transparency, and is used as a gem.

**rhombic dodecahedron** (rhom'-bic) A twelve-sided crystal form in the cubic system, the faces of which are equal rhombi.

**rhombic system** A synonym of *orthorhombic system*. It is an undesirable term because it may be confused with *rhombohedral*.

**rhombohedral** (rhomb-oh'-he-dral)

Pertaining to or crystallizing in rhombohedron. Pertaining to being given the *rhombohedral* system.

**rhombohedral packing** The type of

rangement of uniform solid spheres in a clastic sediment or crystal lattice, characterized by a unit cell of six planes passed through eight sphere centers situated at the corners of a regular rhombohedron. An aggregate with rhombohedral packing has the minimum porosity (25.95%) that can be produced without distortion of the grains. Cf: *cubic packing*. See also: *close packing*; *open packing*.

**rhombohedral system** A division of the *hexagonal system* in which the unit cell is a rhombohedron.

**rhombohedaon** (rhom-bo-he'dron) A crystal form in the hexagonal system bounded by six faces of rhombic outline.

**rhomb spar** Mineral dolomite in rhombohedral crystals.

**rhyolite** (rhy'-o-lite) A group of extrusive igneous rocks, typically porphyritic and commonly exhibiting flow texture, with phenocrysts of quartz and alkali feldspar in a glassy to cryptocrystalline groundmass; also, any rock in that group, the extrusive equivalent of *granite*. Etymol: Greek *rhyax*, from *rhyax*, "stream of lava". Cf: *quartz porphyry*.

**rhythmic sedimentation** (rhyth'-mic) The repetition, through a sedimentary succession, of a sequence of two or more rock units in a particular order and indicating a frequent and predictable recurrence of the same sequence of conditions. It may involve only two components (such as interbedded laminae of silt and

clay), broad changes in sediment character spanning units up to hundreds of meters thick, or any sequence intermediate between these two extremes. Syn: *cyclic sedimentation*.

**rhythmite** (rhyth'-mite) An individual unit of a rhythmic succession or of beds developed by rhythmic sedimentation; e.g. a cyclothem.

**ria** 1. Any long, narrow arm of the sea whose depth and width gradually diminish inland, produced by drowning due to submergence of the lower part of a river valley or an estuary; it is shorter and shallower than a *fjord*. 2. Any broad or estuarine river mouth, including a fjord, not necessarily produced by partial submergence of an open valley.—See also: *estuary*. Etymol: Spanish *ria*, from *ria*, "river".

**rib** 1. A layer or dike of rock forming a small ridge on a steep mountainside. 2. An elongated pillar left in a mine for support. 3. A radial or transverse fold on a fossil shell, e.g. a raised ridge on the coiled conch of an ammonoid or nautiloid.

**ribbon** 1. One of a set of parallel bands or streaks in a mineral or rock, e.g. *slate ribbon*. 2. Said of a vein having alternating streaks of ore with gangue or country rock, or simply of varicolored ore minerals. Cf: *coontail ore*.

**ribbon diagram** A geologic cross section drawn in perspective and joining control points along a sinuous course.

**ribbon injection** A tongue-like igneous intrusion along the cleavage planes of a foliated rock.

**ribbon rock** A rock characterized by a succession of thin layers of differing composition or color, e.g. a vein with narrow quartz bands separated by stripes of altered wall rock.

**Richter scale** (Rich'-ter) A numerical scale of earthquake magnitude, devised in 1935 by the seismologist C. F. Richter. Very small earthquakes, or microearthquakes, can have negative magnitude values. In theory there is no upper limit to the magnitude of an earthquake, but the strength of earth materials produces an actual upper limit of slightly less than 9.

**ridge** 1. A general term for a long narrow elevation, usually sharp-crested and with steep sides. 2. *beach ridge*. 3. An irregular wall of broken floating ice, buckled upward by wind or current pressure. 4. An elongate, steep-sided elevation of the ocean floor, having rough topography. 5. An elevated body part of an animal, projecting from a surface, e.g. a transverse ridge on a crinoid.

**ridge-and-valley topography** A land surface characterized by a close succession of parallel ridges and valleys, and resulting from the differential erosion of highly folded strata of varying resistance. Type region: Ridge and Valley province in the Appalachian Mountains, lying to the west of the Blue Ridge.

**riebeckite** (rie'-beck-ite [ree'-beck-ite]) A blue or black monoclinic mineral of the amphibole group,  $\text{Na}_2(\text{Fe,Mg})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$ . It occurs as a primary constituent in some acid or sodium-rich igneous rocks. See also: *crocidolite*.

**Riecke's principle** The statement in thermodynamics that solution of a mineral tends to occur most readily at points where external pressure is greatest, and that crystallization occurs most readily at points where external pressure is least. It is applied to recrystallization in metamorphic rocks with attendant change in mineral shapes.

**riffle** 1. An expanse of shallow bottom extending across a stream bed, over which the water flows swiftly with a wavy surface owing to submerged obstructions; a shallow rapids of comparatively little fall. 2. A groove in the bottom of an inclined trough or sluice, for trapping gold or other heavy minerals contained in sand or gravel.

**riff** 1. A long, narrow continental trough bounded by normal faults; a *graben* of regional extent, often associated with volcanism. 2. A belt of strike-slip faulting of regional extent. 3. A narrow cleft, fissure, or other opening in rock, made by cracking or splitting. 4. A quarrymen's term for a direction of parting in a massive rock, e.g. granite, at approximately right angles to the *grain*. 5. A narrow, high passage in a cave, the shape of which is controlled

by a joint, fault, or bedding plane.

6. A shallow or rocky place in a stream.

**rift trough** *rift valley*.

**rift valley** 1. A valley that has developed along a tectonic *rift*.

Syn: *rift trough*. 2. The deep central cleft in the crest of the mid-oceanic ridge. Syn: *mid-ocean rift*.

**rig drilling rig**.

**right-handed separation** *right-lateral separation*.

**right-lateral fault** A fault on which the displacement is *right-lateral separation*. Syn: *dextral fault*.

**right-lateral separation** Displacement along a fault such that, in plan view, the side opposite the observer appears displaced to the right. Cf: *left-lateral separation*. Syn: *right-handed separation*.

**rigidity** (ri-gid'-i-ty) The property of a material to resist applied stress that would tend to distort it. A fluid has zero rigidity.

**rigidity modulus** *modulus of rigidity*.

**rille** One of several trenchlike valleys, up to several hundred km long and 1-2 km wide, on the moon's surface. Rilles may be extremely irregular, with meandering courses ("sinuous rilles"), or they may be relatively straight ("normal rilles"); they have relatively steep walls and usually flat bottoms. Rilles are essentially youthful features and apparently represent fracture systems originating in brittle material.

**rillensteins** (ril'-leri-stein) Tiny solution grooves, of about one milli-

meter or less in width, formed on the surface of a soluble rock. Etymol: German, "rilled rock".

**rill mark** A small groove, furrow, or channel in beach sand made by water flowing down the surface after a wave breaks.

**rim** 1. *rimrock*. 2. A ridge of morainal material surrounding a central depression. 3. A *reaction rim* or *corona*. 4. One of the paired bones of the axial skeleton that helps support the body wall in bony fishes and tetrapods.

**rimrock** 1. An outcrop of a horizontal layer of resistant rock, such as a lava flow, at the edge of a plateau or mesa; it generally forms a cliff or ledge. Also, the cliff or ledge so formed. Syn: *rim*.

2. The bedrock forming or rising above the margin of a placer deposit.

**rim syncline** In salt tectonics, a depression that develops around a salt dome, as the salt in the underlying strata is displaced toward the dome.

**ring dike** A dike that is arcuate or roughly circular in plan and is vertical or inclined away from the axis of the arc. Ring dikes are commonly associated with *cone sheets*.

**ring fault** A steep-sided fault pattern that is cylindrical in outline and is associated with *cauldron subsidence*.

**ring-fracture stoping** *Large-scale magmatic stoping* associated with cauldron subsidence.

**rip** A turbulent agitation of water, generally caused in the sea by the

meeting of water currents or the interaction of currents and waves.

*Cf: rip current.*

**riparian** (ri-par'-i-an) Pertaining to or situated on the bank of a body of water, esp. of a river.

**riparian water loss** Evapotranspiration in the stream-bed zone; the difference between the amount of water feeding into a stream from the water table and the amount of water passing the gaging stations during periods when stream flow is not affected by storm runoff.

**rip current** A strong, narrow current, of short duration and high velocity, flowing seaward through the breaker zone as a visible band of agitated water returning to the sea after being piled up on the shore by incoming waves and wind. It consists of a *feeder current*, a *neck*, and a *head*. *Cf: undertow*. Often miscalled a *rip tide*.

**ripple mark** 1. Small-scale subparallel ridges and troughs formed in loose sand by wind, water currents, or waves; also, such forms preserved in consolidated rock. See also: *current ripple mark*; *oscillation ripple mark*. 2. A corrugation on a snow surface, produced by wind.

**riprap** Large fragments of broken rock, thrown together irregularly (as offshore or on a soft bottom) or fitted together (as on the downstream face of a dam). Its purpose is to prevent erosion by waves or currents and thereby preserve a surface, slope, or underlying structure. It is used for irrigation

channels, river-improvement works, spillways at dams, and sea walls for shore protection.

**rip tide** A term used improperly as a syn. of *rip current*. The usage is erroneous because a rip current has no relation to the tide.

**rise** A broad, elongate, smooth elevation of the ocean floor. Syn: *swell*.

**riser** The vertical or steeply sloping surface of one of a series of natural steplike landforms, as those of a glacial stairway or of successive stream terraces. *Cf: tread*.

**Rias** The third of four classical glacial stages of the Pleistocene of Europe, above the Mindel and below the Würm.

**river bar** A ridge-like accumulation of alluvium in the channel, along the banks, or at the mouth, of a river. It is commonly emergent at low water and constitutes a navigational obstruction.

**river basin** The entire area drained by a river and its tributaries. *Cf: drainage basin*.

**river bottom** The alluvial land along a river

**river flat** The alluvial plain adjacent to a river; a bottom.

**river-pebble phosphate** A term used in Florida for a transported, dark variety of *pebble phosphate* obtained from bars and flood plains of rivers. *Cf: land-pebble phosphate*.

**river system** A river and all of its tributaries.

**river terrace stream survey**

**road metal** Crushed and graded

stone used in the foundation or "base course" of paved highways.

**roche moutonnée** (roche mou-ton-née' [rosh moo-to-nay']) A glacially sculptured knob of bedrock, with its long axis oriented in the direction of ice movement, an upstream (stoss) side that is gently inclined, rounded, and striated, and a downstream (lee) side that is steep, rough, and hackly. Pl: *roches moutonnées*. Syn: *sheepback rock*.

**rock 1** An aggregate of one or more minerals, e.g. granite, shale, marble; or a body of undifferentiated mineral matter, e.g. obsidian, or of solid organic material, e.g. coal. 2. Any prominent peak, cliff, or promontory, usually bare, when considered as a mass, e.g. the Rock of Gibraltar. 3. A rocky mass lying at or near the surface of a body of water, or along a jagged coastline, esp. where dangerous to shipping. 4. A slang term for a gem or diamond.

**rock association** A group of igneous rocks within a petrographic province that are related chemically and petrographically, generally in a systematic manner such that chemical data for the rocks plot as smooth curves on variation diagrams. Syn: *kindred; association*.

**rock bolting** A method of securing or strengthening rocks in mine workings, tunnels, or rock abutments by inserting and firmly anchoring rock bolts in predrilled holes that range in length from less than one meter to about 12 m.

A device on the leading end expands when the bolts are tightened.

**rock burst** A sudden and often violent breaking of a mass of rock from the walls of a tunnel, mine, or deep quarry, caused by the release of accumulated strain energy. It may result in closure of a mine opening, or projection of broken rock into it, accompanied by ground tremors, rockfalls and air concussions.

**rock crystal** *quartz crystal*

**rock cycle** A sequence of events involving the formation, alteration, destruction, and reformation of rocks as a result of such processes as magmatism, erosion, transportation, deposition, lithification, and metamorphism.

**rock-defended terrace 1** A river terrace protected from later undermining by a projecting ledge or outcrop of resistant rock at its base. 2. A marine terrace protected from wave erosion by a mass of resistant rock at the base of the wave-cut cliff in the overlying coastal-plain sediments.

**rock drumlin** A hill having the form of a *drumlin* but consisting of bedrock veneered with till.

**rockfall 1.** The relatively free falling of a newly detached segment of bedrock of any size from a cliff, steep slope, cave, or arch. Cf: *sturzstrom*. 2. The mass of rock moving in or moved by a rockfall; a mass of fallen rocks.

**rock flour** Finely ground rock particles, chiefly silt size, resulting from glacial abrasion. Cf: *glacial*



*milk.*

**rock-forming** Said of those minerals that enter into the composition of rocks, and determine their classification. The more important rock-forming minerals include quartz, feldspars, micas, amphiboles, pyroxenes, olivine, calcite, and dolomite

**rock glacier** A mass of angular boulders and finer material, with interstitial ice or an ice core. It occurs in high mountains in a permafrost area, and is derived from a cirque wall or other steep cliff. Rock glaciers have the general appearance and slow movement of small valley glaciers.

**rock hound** An amateur mineralogist.

**rock mantle** *regolith*.

**rock pediment** A *pediment* developed on a bedrock surface

**rock pressure** 1. The pressure exerted by surrounding solids on the support system of underground openings, including that caused by the weight of the overlying material, residual unrelieved stresses, and pressures associated with swelling clays 2. The compressive stress within the solid body of underground geologic material. 3. *geostatic pressure*.

**rock salt** 1. Coarsely crystalline *halite* occurring as a massive or granular aggregate, and constituting a nearly pure sedimentary rock that may occur in domes or plugs or as extensive beds resulting from evaporation of saline water. 2. Artificially prepared salt in the form of large crystals or

masses.

**rock series** *igneous-rock series*.

**rockslide** 1. The downward and usually rapid movement of newly detached segments of bedrock, sliding on a surface of bedding, jointing, or faulting. The moving mass usually breaks up into many small units. Rockslides occur in high mountain ranges, as the Alps or Canadian Rockies. 2. The mass of rock moving in or moved by a rockslide.

**rock-stratigraphic unit** *lithostratigraphic unit*.

**rock stream** *block stream*.

**rock terrace** A stream terrace produced on the side of a valley by erosion in horizontal beds of unequal resistance, composed of strong bedrock that is worn back less rapidly than the weaker beds above and below. Syn: *cut terrace*.

**rock unit** *lithostratigraphic unit*.

**rock waste** *debris*.

**rock wool** *mineral wool*.

**rod** 1. A rodlike or elongated sedimentary particle. 2. A graduated staff or pole, used as a target in surveying; specif. a *level rod*. 3. A unit of length equal to 16.5 feet, or 5.029 meters.

**rodding structure** In metamorphic rocks, a linear structure in which the stronger parts, such as vein quartz or quartz pebbles, have been shaped into parallel rods. Syn: *mullion structure*.

**roll** 1. An elongate protrusion of shale, siltstone, or sandstone from the roof or floor into a coal seam. Cf: *horseback*. 2. A *roll ore body*.

3. A primary sedimentary structure produced by subaqueous slump, e.g. a *flow roll*.

**roll-front orebody** A *roll orebody* bounded on the concave side by oxidized altered rock typically containing hematite or limonite, and on the convex side by relatively reduced altered rock typically containing pyrite and organic matter.

**roll orebody** A uranium and/or vanadium orebody in a sandstone lens or layer, which cuts across bedding in sharply curving forms, commonly C-shaped or S-shaped in cross section. Two types can be distinguished. Roll orebodies of the Colorado Plateau type have their longest dimension parallel to the axes of buried sandstone lenses representing former stream channels, and are surrounded by a wide halo of reduced rock. Orebodies of the Wyoming type are crescent-shaped in cross section and typically form in relatively thick, tabular, or elongate sandstone bodies, between mudstone layers. See also: *roll-front orebody*. Syn: *roll*.

**rollover** A feature of some Gulf Coast *growth faults*, in which the beds of the downthrown block dip toward the fault surface in an orientation opposite to that produced by drag.

**roof** 1. The rock lying above a coal bed, or the *back* above an orebody. 2. The country rock bordering the upper surface of an igneous intrusion.

**roof foundering** The collapse of

rocks into an underlying reservoir of magma.

**roof pendant** A downward projection of country rock into an igneous intrusion. Cf: *cupola*. Syn: *pendant*.

**roof rock** A shale or other impervious rock that acts as a barrier to the movement of oil or gas; it overlies a reservoir rock to form a trap.

**room-and-pillar** 1. Said of a system of mining in which the ore is mined in rooms separated by pillars of undisturbed rock left for roof support. 2. Said of a coral-reef structure characterized by interconnected and roofed-over surge channels or caverns.

**root** 1. According to the *Airy hypothesis*, the downward extension of lower-density crustal material as isostatic compensation for its greater mass and topographic elevation. 2. The basal part of a fold nappe that was originally linked to its source or *root zone*. 3. The *bottom* of an ore deposit, or the conduit leading up through the basement rocks to an ore deposit.

**root zone** 1. The source or original attachment of the root of a nappe. 2. That zone in the crust from which thrust faults emerge.

**ropy lava** *pahoehoe*.

**rose diagram** A circular or semicircular graph indicating values in several directions of bearing, consisting of radiating rays drawn proportional in length to the value, e.g. for wind currents or joint directions.

**rose quartz** Quartz with a rose-pink color, used as a gem or as an ornamental stone.

**rosette** (ro-sette) 1. A radially symmetrical, sand-filled crystal-line aggregate or cluster with a fancied resemblance to a rose, formed in sedimentary rocks by barite, marcasite, or pyrite. 2. Any of various radial, flower-shaped plates in invertebrate animals, e.g. a basal plate in some free-swimming crinoids.

**rosin jack** (ros'-in) A yellow variety of sphalerite.

**rosin tin** A reddish or yellowish variety of cassiterite.

**Rossi-Foral scale** One of the earthquake intensity scales, devised in 1883. It has been replaced by the *modified Mercalli scale*. Cf: *Richter scale*.

**rotary drilling** (ro'-ta-ry) The chief method of drilling deep wells, esp. for oil and gas. A hard-toothed drill bit at the bottom of a rotating drill pipe grinds a hole in the rock. Lubrication and cooling are provided by continuously circulating drilling mud, which also brings the well cuttings to the surface. Cf: *cable tools*.

**rotary fault** *rotational fault*.

**rotary table** In rotary drilling, a power-driven circular platform on the derrick floor that rotates the *kelly*, *drill pipe*, and *drill bit*. It is sometimes used as the zero-depth reference for downhole measurements. Abbrev: *RT*.

**rotational cylindrical fold** (ro-ta'-tion-al) A cylindrical fold, the axial surface of which has been dis-

torted by a subsequent or cross fold.

**rotational fault** (ro-ta'-tion-al) A fault on which rotational movement is exhibited; a partial syn. of *hinge fault*. Cf: *scissor fault*.

**rotational flow** Turbulent flow involving all parts of a moving liquid.

**rotational landslide** A slide in which shearing takes place on a well defined, curved surface, concave upward, producing a backward rotation in the displaced mass. See also: *Toreva block*.

**rotational movement** Apparent fault-block displacement in which the blocks have rotated relative to one another, so that alignment of formerly parallel features is disturbed. Cf: *translational movement*. See also: *rotational fault*.

**rotational strain** Strain in which the orientation of the principal axes of strain is different before and after deformation. Cf: *irrotational strain*.

**rotational wave** *S wave*.

**rotational axis** (ro-ta'-tion) *axis of symmetry*.

**rounded** Said of a sedimentary particle whose original edges and corners have been smoothed off and whose original faces are almost completely removed by abrasion. The original shape, however, is still readily apparent. Also, said of the *roundness class* containing rounded particles. Not to be confused with *sphericity*.

**roundness** The degree of abrasion of a clastic particle, as shown by the sharpness of its edges and cor-

ners. The value is conveniently computed from a projection or cross section; thus, roundness may be defined as the ratio of the average radius of curvature of the corners of the particle image to the radius of the maximum inscribed circle. A perfectly rounded particle (such as a sphere) has a roundness value of 1.0. The term should not be confused with *sphericity*: a nearly spherical particle may have sharp corners and be angular, while a flat pebble may be well-rounded. Cf: *flatness*. See also: *angularity*; *roundness class*.

**roundness class** An arbitrarily defined range of roundness values for the classification of sedimentary particles: *angular*, *subangular*, *subrounded*, *rounded*, and *well-rounded*. A sixth class, *very angular*, may be recognized.

**royal agate** (roy'-al) A mottled variety of obsidian.

**royalty** (roy'-al-ty) The landowner's share of the value of minerals produced on a property, free of expenses of development and production; commonly a fractional share of the current market value (oil and gas) or a fixed amount per ton (mining).

**RT rotary table.**

**rubble** 1. A loose mass of angular rock fragments, commonly overlying outcropping rock; the unconsolidated equivalent of a *breccia*. Cf: *talus*. 2. Loose, irregular pieces of artificially broken stone as it comes from the quarry.

**rubellite** (ru'-bel-lite) A pale rose-red to deep ruby-red transparent lithian variety of tourmaline, used as a gemstone.

**rubidium-strontium age method** (ru-bid'-i-um-stron'-ti-um) Determination of an age for a mineral or rock in years based on the ratio of radiogenic strontium-87 to rubidium-87 and the known radioactive decay rate of rubidium-87. If ratios are measured for more than one phase of a single rock, or for a number of related rocks that differ in rubidium content, an *isochron* may be drawn.

**ruby** The red variety of corundum, containing small amounts of chromium, used as a gemstone and the birthstone for July Cf: *sapphire*.

**ruby silver** A red silver-sulfide mineral; specif. "dark ruby silver" or pyrargyrite and "light ruby silver" or proustite.

**rudaceous** (ru-da'-ceous) Said of a sedimentary rock composed of a significant amount of fragments coarser than sand grains; pertaining to a *rudite*. Also said of the texture of such a rock.

**rudite** (ru'-dite) A general name used for consolidated sedimentary rocks composed of rounded or angular fragments coarser than sand (granules, pebbles, cobbles, boulders, or gravel or rubble); e.g. conglomerate, breccia, and calcirudite. The term is equivalent to the Greek-derived term, *psophite*. Etymol.: Latin *rudus*, "debris, rubble". See also: *lutite*; *arenite*. **rugose** (ru-gose') Coarsely wrin-

kled, uneven, rough.

**rugose coral** Any zoantharian belonging to the order Rugosa, characterized by calcareous corallites that may be solitary and cone-shaped or cylindrical, curved or erect, compound and branching or massive. Range, Ordovician to Permian.

**rule of V's** The outcrop of a formation that crosses a valley forms an acute angle (a V) that points in the direction in which the formation lies underneath the stream. The V points upstream where the outcrops of horizontal beds parallel the topographic contours, where the beds dip upstream, or where the beds dip downstream at a smaller angle than the stream gradient; the V points downstream where the beds dip downstream at a larger angle than the stream gradient.

**run** 1. A branching or fingerlike extension of the feeder of an igneous intrusion. Runs typically spread laterally at several stratigraphic levels. 2. A flat irregular ribbonlike orebody following the stratification of the host rock. 3. A brook or a small creek.

**running ground** 1. In mining, incoherent earth, soil, or rock that will not stand, esp. when wet, and that tends to flow into mine workings. 2. A tunnelman's term for soil that runs into a tunnel on removal of roof or side support; for example, dry cohesionless sand.

**runoff** That part of the precipitation appearing in surface streams. See also: *direct runoff*.

**run-of-mine** Said of ore in its natural, unprocessed state; pertaining to ore just as it is mined.

**rapture fracture.**

**rutilated quartz** (ru'-ti-lat'-ed) Quartz characterized by the presence of enclosed needlelike crystals of rutile. See also: *sagenite*.

**rutile** (ru'-tile) A reddish-brown tetragonal mineral:  $\text{TiO}_2$ . It is trimorphous with anatase and brookite, and often contains a little iron. Rutile forms prismatic crystals in other minerals (esp. quartz); it occurs as a primary mineral in some acid igneous rocks, in metamorphic rocks, and as residual grains in beach sands. It is an ore of titanium.

**R wave** *Rayleigh wave*

## S

**sabkha** (sab'-kha) 1. A supratidal environment of sedimentation, formed under arid to semiarid conditions on restricted coastal plains just above normal high-tide level. It is gradational between the land surface and the intertidal environment. Sabkhas are characterized by evaporite-salt, tidal-flood, and eolian deposits, and are found on many modern coastlines, e.g. Persian Gulf, Gulf of California. 2. In the rock record, a sabkha facies may be indicated by evaporites, absence of fossils, thin flat-pebble conglomerates, stromatolitic laminae, mud cracks, and dolomitization. The sabkha environment may have been significant in the formation of certain petroleum and sulfide-mineral deposits. —Etymol Arabic. Also spelled *sebkha*.

**saccharoidal** (sac'-cha-roi'-dal) Having a granular texture resembling that of loaf sugar, said of the texture of aplite and of some sandstones and marbles. Syn. *sacrose*.

**saddle** 1. A low point in the crest line of a fold, common v between the heads of streams flowing in opposite directions. It may be broad and flat, resembling a saddle in shape. 2. A low point or sag along the surface of a or axial trend of an anticline. 3. An inflection of a surface and a corresponding inflection of lines directed forward toward the aperture. Ant: *lobe*. 4. *saddle reef*.

**saddle fold** A type of fold that has an additional flexure near its crest, at right angles to that of the parent fold and of much larger radius.

**saddle reef** A mineral deposit associated with the crest of an antichinal fold and following the bedding planes, usually found in vertical succession, esp the gold-bearing quartz veins of Australia. Syn. *saddle*.

**sagenite** (sag'-e-nite [saj'-e-nite]) 1. A variety of rutile that occurs in groups of needlelike crystals crossing at 60 degrees, often enclosed in quartz or other minerals. See also *Venus hair*. 2. A crystal of sagenite. Also, a similar crystal of tourmaline, goethite, actinolite, or other minerals penetrating quartz. 3. Sagenitic quartz, esp *rutulated quartz*. —Etymol Latin *sagena*, "large fishing net".

**sagittal** (sag'-it-tal) Pertaining to or situated in the median anterior-posterior plane of a body having bilateral symmetry, or in any plane parallel thereto, e.g. a "sagittal plane" dividing a trilobite into two similar halves.

**sagittate** (sag'-it-tate) Like an arrowhead in form, triangular v in the basal lobe pointing downward or concave upward on stalk.

**sag pond** A small body of water, usually in an enclosed depression, that collects water from the

pounded drainage; specif. one of many ponds and small lakes along the San Andreas Fault in California.

**salada** (sa-la'-da) A term used in the southwestern U.S. for a salt-covered plain where a lake has evaporated. Etymol: Spanish, feminine of *salado*, "salted, salty". See also: *playa*.

**salar** (sa-lar') A term used in the southwestern U.S. and in the Chilean nitrate fields for a salt flat, or for a salt-encrusted depression that may represent the basin of a salt lake. Etymol. Spanish, "to salt". Pl: *salares*; *salars*. See also: *playa*.

**salic** (sal'-ic) A mnemonic term derived from "s" for silica and "al" for alumina and applied to the group of standard normative minerals in which one or both of these elements are present in large amount, including quartz, the feldspars, and the feldspathoids. Cf. *femic*; *mafic*; *felsic*.

**salient** (sa'-li-ent) adj. Projecting upward or outward, as a promontory on a coast.—n. 1. That part of an orogenic belt in which the axial traces of the folds are convex toward the outer edge of the folded belt. Ant: *recess*. 2. A landform that extends outward from its surroundings, e.g. a spur on the side of a mountain. Ant: *reentrant*.

**salina** (sa-li'-na) 1. A place where crystalline salt deposits are found, such as a *salada* or a salt-encrusted *playa*. 2. A body of saline water, such as a salt pond or brine

or a *playa* lake. 3. *salt marsh*.—Etymol: Spanish, "salt pit, salt mine". Anglicized equivalent: *saline*.

**saline** (sa'-line) n. 1. A natural deposit of halite or of any soluble salt; e.g. an evaporite. Often used in the plural. 2. An anglicized form of *salina*. 3. A spring of salt water. 4. A term used along the coast of Louisiana for a body of water behind a barrier island.—adj. 1. Salty; containing sodium chloride, e.g. seawater. 2. Having a salinity greater than that of seawater, as in a *brine*. 3. *hypersaline*. 4. Said of a taste resembling that of common salt, esp. in describing the properties of a mineral.

**salinity** (sa-lin'-i-ty) The total quantity of dissolved salts in seawater, measured by weight in parts per thousand, when all the carbonate has been converted to oxide, all the bromide and iodide to chloride, and all the organic matter has been completely oxidized. Salinity is usually computed from some other factor, such as chlorinity. It may also be defined in terms of electrical conductivity relative to normal seawater.

**salinity current** A *density current* in the ocean, the flow of which is caused, controlled, or maintained by, or relatively greater density due to excessive salinity.

**salt** n. A general term for naturally occurring sodium chloride, NaCl. Syn: *halite*, *common salt*, *rock salt*.—adj. Containing salt or salt

valuable ore in the ground or in a mine, in order to give a false impression of the richness of the property.

**salt anticline** A diapiric or piercement structure, like a *salt dome* except that the salt core is linear rather than equidimensional, e.g. the salt anticlines in the Paradox basin of the central Colorado Plateau.

**saltation** (sal-ta'-tion) 1 Sediment transport in which particles are moved forward in a series of short leaps or bounces, e.g. sand grains bounding downstream in a current not turbulent enough to retain them in *suspension*. It is intermediate between suspension and *traction*. Etymol: Latin *saltare*, "to jump" 2 Sudden evolution of a new type of organism, derived in a single generation from older ones without intermediate forms. The process appears to be almost impossible genetically.

**saltatory evolution** (sal'-ta-to'-ry) The theory of evolution by *saltation*.

**salt dome** A general term for a piercement structure or *diapir* with a columnar *salt plug* at its core, a *cap rock* of anhydrite and limestone, and upturned and complexly faulted sediments next to the salt plug. Salt domes are characteristic features of the Gulf Coastal Plain in North America and the North German Plain in Europe, and occur in many other regions. Cf: *salt anticline*. See also: *salt tectonics*.

**salt glacier** Mass of mobile salt at the earth's surface that flows slowly outward from a center, generally an exposed salt plug; known only in such an extremely arid region as that adjacent to the Persian Gulf.

**salt lake** A body of water in an arid or semiarid region, having no outlet to the sea, containing a high concentration of dissolved salts (principally sodium chloride). Examples include the Great Salt Lake in Utah, and the Dead Sea in the Near East. See also: *alkali lake*; *bitter lake*.

**salt lick** A place to which animals (e.g. deer, cattle, bison) go to lick up salt lying on the surface of the ground, as in an area surrounding a salt spring. Syn: *lick*.

**salt marsh** A marsh periodically flooded by salt water. Cf: *tidal marsh*. See also: *low marsh*; *salt-ing*; *sea marsh*; *open coast marsh*; *tidal-delta marsh*; *salt-marsh plain*. Syn: *salt*.

**salt pan** 1. A small shallow depression in which water accumulates and evaporates, leaving a salt deposit. Also, the shallow brackish water occupying a salt pan. See also: *playa*. 2. A large pan for making salt by evaporation.

**salt-peter** 1. Naturally occurring potassium nitrate; *niter*. 2. A general term for earthy cave deposits of nitrate minerals.

**salt plug** The core of a *salt dome*. It is a nearly equidimensional column, one to two kilometers in diameter, that has risen through the enclosing sediments from a



mother salt bed 5 to 10 kilometers below. Most plugs have nearly vertical walls, but some overhang.

**salt prairie soda prairie.**

**salt tectonics** A general term for the study of the structure and mechanism of emplacement of salt domes and other salt-controlled structures.

**salt-water encroachment** Displacement of fresh ground water by the advance of salt water due to its greater density, usually in coastal and estuarine areas but also by movement of brine from beneath a playa lake toward wells discharging fresh water. Encroachment occurs when the total head of the salt water exceeds that of adjacent fresh water. Syn: *intrusion*.

**sample n.** A representative unit of a rock, fluid, ore, fossil population, or other entity for analysis or display.—*v.* To collect samples

**sample log(sam'-ple)** A graphic record of the strata penetrated in drilling a well, usually in the form of a strip with a standard vertical scale. It is compiled by a geologist from microscopic examination of well cuttings and cores. In addition to lithology, shown by colors or patterns, sample logs usually indicate the points at which oil, gas, or water was found, and the lengths of casing used. See also: *strip log; interpretive log; percentage log*. Syn: *graphic log*.

**sand 1.** A detrital particle smaller than a granule and larger than a silt grain, having a diameter in the

range of 1/16 to 2 mm. 2. A loose aggregate of such particles, most commonly of quartz. 3. *sandstone* 4. A driller's term for any visibly granular sediment, or for any fluid-productive porous sedimentary rock in a well. See also: *oil sand*

**sand bar** A bar or ridge of sand built up to or near to the surface of the water by currents in a river or by wave action in coastal waters

**sand crystal** A large euhedral or subhedral crystal (as of barite, gypsum, and esp. calcite) loaded with detrital-sand inclusions (up to 60%), developed by growth in a sandstone during cementation. See also: *crystal sandstone*

**sand dune dune.**

**sand flood** A vast body of sand moving over or borne along on a desert floor, as in Arabia.

**sand glacier** An accumulation of sand that is blown up the side of a hill or mountain and through a pass or saddle, and then spread out on the opposite side to form a wide fan-shaped plain

**sanding up** Filling-in or choking with sand, as in a well that produces sand mixed with oil and gas.

**sand line 1.** A mark made by glacier ice, 5-10 cm long and fine as a hair similar to a mark made by fine sandpaper 2. A wire line used in cable-tool drilling to raise and lower the bailer.

**sand pipe** A tubular cavity, from a few inches to many feet in depth, commonly in calcareous rocks,

filled with sand

**sand-shale ratio** The ratio of the thickness or percentage of sandstone (and conglomerate) to that of shale in a stratigraphic section disregarding the amount of non-clastic material Cf. *clastic ratio*

**sand size** A term used in sedimentology for a volume greater than that of a sphere with a diameter of 1/16 mm (0.0025 in.) and less than that of a sphere with a diameter of 2 mm (0.08 in.)

**sandstone** A clastic sedimentary rock composed of grains of sand size set in a matrix of silt or clay and more or less firmly united by a cementing material (commonly silt or iron oxide or calcium carbonate) the consolidated equivalent of sand. The sand particles usually consist of quartz and the term 'sandstone' when used without qualification indicates a rock containing about 85-90% quartz. Syn. *sand sandrock*

**sandstone dike** A *clastic dike* composed of lithified sand

**sandstone pipe** A *clastic pipe* consisting of sandstone. It may originate in filling of a spring vent, filling of a solution cavity in underlying limestone, or in various other ways

**sand stream** A small sand delta spread out at the mouth of a gully, or a deposit of sand along the bed of a small creek, formed by a torrential rain

**sand wave** 1 A general term for a wavelike *bed form* in sand. 2 A generally large and asymmetrical *bed form* in sand, with a wavelike

form but lacking the deep scour associated with *dunes* and *mega ripples*. 3 A general term to describe very large subaqueous sand ripples

**sandy gravel** Gravel containing 50 to 75% of sand

**Sangamon** (San'-ga-mon) Pertaining to the third classical interglacial stage of the Pleistocene Epoch in North America, after the Illinoian glacial stage and before the Wisconsin

**sanidine** (san'-i-dine) A high-temperature mineral of the alkali feldspar group,  $KAlSi_3O_8$ . It is a disordered monoclinic form, occurring in clear glassy crystals embedded in unaltered acid volcanic rocks such as trachyte

**sanidine facies** (san-i-din-ite)

The set of metamorphic mineral assemblages in which are found tridymite, mullite, sanidine, and other minerals indicating metamorphism at maximum temperature and minimum pressure, e.g. xenoliths in basic lavas

**saponite** (sap'-o-nite) A triclinic aluminous-magnesium-rich clay mineral of the montmorillonite group  $(Ca/2, Na)_3 (Mg, Fe)_3 (Si, Al)_4 O_{10} (OH)_2 \cdot 4H_2O$ . It represents an end member in which the replacement of aluminum by magnesium in the octahedral sheets is essentially complete. Etymol. Greek *sapon*, "soap"

**sapphire** (sap'-phire) Any pure, gem-quality corundum other than *ruby*, esp. the fine blue transparent variety of crystalline corundum of great value, containing

small amounts of oxides of cobalt, chromium, and titanium, and found esp in the Orient (Kashmir, Burma, Thailand, and Ceylon) Blue sapphire is the birth stone for September

**sapping** 1 Erosion along the base of a cliff wearing away the softer layers and allowing the rocks above to fall in large blocks 2 Erosion around the spring at the headwaters of a stream 3 Undercutting along the headwall of a cirque, owing to frost action at the bottom of the *bergschrund*

**saprolite** (sap'-ro-lite) A soft, earthy, clay-rich thoroughly decomposed rock formed in place by chemical weathering of igneous or metamorphic rocks esp in humid or tropical or subtropical climates The color is commonly red or brown Saprolite is characterized by preservation of structures that were present in the unweathered rock Cf *laterite*

**sapropel** (sap'-ro-pel) A jellylike ooze or sludge composed of plant remains, most often algae, putrefying in an anaerobic environment on the shallow bottoms of lakes and seas It may be a source material for petroleum and natural gas

**sardonyx** (sar'-do-nyx) A gem variety of chalcedony that is like *onyx* in structure but includes straight parallel red or brown bands of sard alternating with white, black, or colored bands of another mineral

**Sargasso Sea** (Sar-gas'-so) A warm region of the North Atlan-

tic Ocean to the east and south of the Gulf Stream, characterized by a large mass of floating seaweed that is mainly sargasso a brown alga of the genus *Sargassum*

**satin spar** A white translucent fibrous variety of gypsum, characterized by a silky luster

**saturated** (sat u rat-ed) 1 Said of the condition in which the pores of a material are filled with a liquid, usually water 2 Said of a rock having quartz in its pores 3 Said of a mineral that can form in the presence of free silica i.e. one that contains the maximum amount of combined silica also said of an igneous rock composed chiefly of such minerals

**saturated zone** *zone of saturation*

**saturation** (sat u ra' tion) 1 The degree to which the pores in a rock contain oil, gas, or water, generally expressed in percent of total pore space 2 The degree to which silica saturated minerals are present in an igneous rock 3 The maximum possible content of water vapor in the earth's atmosphere for a given temperature

**saturation line** 1 The line on a variation diagram of an igneous rock series that represents saturation with respect to silica Rocks to the right of it are oversaturated, those to the left are undersaturated 2 The line on a glacier between the zone of partial melting, where the snow layer is not completely soaked, and the zone where it is saturated with meltwater

**sausage structure** (sau'-sage) *bou-*

*image.*

**saussurite** (saus'-su-rite) A tough, compact mineral aggregate consisting of a mixture of albite (or oligoclase) and zoisite or epidote. It is produced by alteration of calcic plagioclase.

**savanna** (sa-van'-na) 1 An open, grassy, essentially treeless plain, esp. as developed in tropical or subtropical regions. 2 Along the southeastern Atlantic Coast of the U.S. the term (often spelled *savannah*) is used for marshy alluvial flats with occasional clumps of trees.

**scabland** An elevated area, underlain by flat-lying basalt flows, with a thin soil cover and sparse vegetation, and usually with deep, dry channels scoured into the surface. An example is the Columbia lava plateau of eastern Washington, which was widely and deeply eroded by glacial meltwaters.

**scalar** (sca'-lar) Said of the physical features of a rock fabric that are nondirectional, e.g. a grain shape, porosity, or crystal habit.

**scale** 1 *map scale* 2 Loose, thin fragments of rock, threatening to fall from the wall or roof of a mine. 3 Any of several small platelike structures in invertebrate fossils.

**scalenoedron** (sca-le'-no-he'-dron) A closed crystal form whose faces are scalene triangles; the hexagonal scalenoedron has twelve faces, and the tetragonal scalenoedron has eight. Adj. *scalenoedral*.

**scanning electron microscope** An

*electron microscope* in which a finely focused beam of electrons is repeatedly moved across the specimen to be examined, and the reflected and emitted electron intensity is measured and displayed, sequentially building up an image. The ultimate magnification and resolution is less than for the conventional electron microscope, but opaque objects can be examined, and great depth of field is obtained. Abbrev. SEM.

**scanning transmission electron microscope** A *transmission electron microscope* that has the capability of forming the electron beam into a fine probe ( $< 100\text{\AA}$  in diameter) and scanning it across a thin specimen. The advantage is the fine probe and the electronic manipulation of the detected transmitted beam. In some instruments, the electron-beam size can be reduced to several angstroms in diameter, resulting in high-resolution images of single large atoms, e.g. uranium. Abbrev. STEM.

**scaphopod** (scaph'-o-pod) Any benthic marine univalve mollusk belonging to the class Scaphopoda, characterized by an elongate body completely surrounded by mantle and a tubular calcareous shell ("tusk shell") open at both ends. Range, Devonian to present.

**scapolite** (scap'-o-lite) 1. A group of tetragonal minerals of general formula  $(\text{Na,Ca,K})_4[\text{Al}_3(\text{Al,Si})_3\text{Si}_6\text{O}_{24}]\text{X}(\text{Cl,F,OH,CO}_3,\text{SO}_4)$ . Scapolite minerals characteristically

occur in calcium-rich metamorphic rocks or in igneous rocks as the products of alteration of basic plagioclase feldspars. 2. A specific mineral of the scapolite group.

**scarp** 1. A line of cliffs produced by faulting or erosion. The term is an abbreviation of *escarpment*, and the two terms have essentially the same meaning. See *fault*. **scarp erosion** **scarp** 2. *beach scarp*.

**scatter diagram** *point diagram*

**schelinite** (schee' lite) A brown to drab mineral  $\text{CaWO}_4$ . It is found in pneumatolytic veins associated with quartz and fluorite; to how's blue color. Schelinite is an ore of tungsten.

**schiller** (schil' ler) A syn of *play of color*. Etymol. German. See also *schillerization*.

**schillerization** (schil' ler i za' tion) The development of *schiller* or play of color in a mineral due to the arrangement of minute inclusions in the crystal.

**schist** A strongly foliated crystalline rock formed by dynamic metamorphism that has well developed parallelism of more than 50% of the minerals present, particularly those of lamellar or elongate prismatic habit, e.g., mica and hornblende. Cf. *gneiss*, *phyllite*.

**schistose** (schist' ose) Said of a rock displaying schistosity. Cf. *gneissic*.

**schistosity** (schis' tos' i-ty) The foliation in schist or other coarse-grained crystalline rock due to

the parallel arrangement of mineral grains of the platy or prismatic types, usually mica. It is considered by some to be a type of *cleavage*. Adj. *schistose*.

**schlieren** (schlier' en) Tabular bodies, generally a few inches to tens of feet long, that occur in plutonic rocks. They have the same general mineralogy as the plutonic rocks, but because of differences in mineral ratios, they are darker or lighter, the boundaries with the rock tend to be transitional. Some schlieren are molified inclusions; others may be segregations of minerals. Cf. *flow layer*.

**Schmidt net** A coordinate system used to plot a *Schmidt projection* used in crystallography for statistical analysis of data obtained, e.g., from universal stage measurements, and in structural geology for plotting azimuth, as angle measured clockwise from north, and about a point directly beneath the observe.

**Schmidt projection** A term used in crystallography and structural geology for a *Lambert azimuthal equal area projection* of the lower hemisphere of a sphere onto the plane of a meridian. See also *Schmidt net*.

**schorl** Black to iridescent

**scientific method** (sci' en' tif' ic) A general term for the lines of reasoning that scientists tend to follow in attempting to explain natural phenomena. It includes observation, analysis, synthesis, classification, and inductive inference, in order to arrive at a

*synthesis* that seems to explain a problem. Hypothesis becomes a theory if it withstands repeated testing and application. Deduction is one of the theory may then explain additional problems. Since the term actually covers several methods, it is often used in the plural. See also *induction deduction*.

**scintillation** (sint-il-lä-tion) A scintillation flash of light produced by ionizing agent, such as radioactive particles, in a phosphor or scintillator.

**scintillation counter** An instrument that measures ionizing radiation by counting individual scintillations of a substance. It consists of a phosphor and a photomultiplier tube that registers the phosphor's flashes. It is used in spectrometry as well as prospecting. Syn: *scintillometer*, *scintillometer*. (sint-il-lom-ee-ter)  
*scintillation counter*

**scissor fault** A fault on which there is no regular offset or separation along the strike from an initial point of no offset, with reverse offset in the opposite direction. The separation may be due to a crissolike or pivotal movement on the fault, or it may be the result of unidirectional strike slip movement, not a fault across a synclinal or anticlinal fold. The terminology is not rigorous. *pivot fault*, *hinge fault*, *rotary fault*, *rotational fault* are similarly called.

**scoliodont** (sco-lee-od-ont) The fossil jaw, with denticles of an

annelid worm. It is composed of silica and chitin, the chitin being carbonized to a jet black during fossilization.

**scolithus** (sco-li'-thus) Any of various wormlike trace-fossil structures found in Cambrian and Ordovician quartz-rich sandstones (and also in upper Precambrian rocks), consisting of narrow vertical and usually straight tubes or tube fillings, about 0.2-1 cm in diameter, commonly crowded, and generally flaring out into cup-like depressions at their tops. They are believed to be the fossil burrows of marine worms and are assigned to the 'genus' *Scolithus*.

**scoria** (sco-ree-ä) A vesicular cindery crust on the surface of lava flows, the cellular nature of which is due to the escape of volcanic gases before solidification; it is heavier, darker, and more crystalline than pumice. Cinder is sometimes used synonymously. Adj: *scoriaceous*.

**scoriaceous** (sco-ree-ä-ee-us) Said of the texture of a coarsely vesicular pyroclastic rock, such as scoria; also, said of a rock exhibiting such texture.

**scour** 1. Concentrated erosive action esp. by streamy water as on the outside curve of a bend; also, a place in a stream bed swept clear by a swift current. 2. Erosion of the sea floor by powerful tidal currents. 3. In engineering, an artificial flow of water intended to remove mud from a stream bed; also, the structure built to

produce such a current  
**scour and fill** Alternate excavation and refilling of a channel, as by tides, or by a stream in flood also a small sedimentary structure consisting of an erosional channel that was later filled Cf *cut and fill, washout*

**scour mark** A mark produced by the cutting or scouring action of a current of water flowing over the bottom e.g. a *flute*

**secrex** A term commonly used in Great Britain as a loose equivalent of *talus*, it may also include any loose fragmental material lying on or mantling a slope

**screen analysis** Determination of the particle-size distribution of a soil, sediment, or ore by measuring the percentage of the particles that will pass through standard screens of various sizes

**screening** The operation of passing loose materials (such as gravel or coal) through a series of screens so that constituent particles are separated into defined sizes

**scroll** 1 One of a series of crescentic deposits built on the inner bank of a stream meander 2 *meander scroll*

**S-dolostone** Stratigraphically controlled dolostone occurring in extensive beds generally intertongued with limestone Cf *limestone dolostone*

**se** In structural petrology a face defined by the preferred orientation of grains externally e.g. a *phyroblast*. It may or may not be parallel to the preferred orientation of minerals within the por-

phyroblast Cf *sl*

**sea arch** An opening through a headland, formed by wave erosion and leaving a bridge of rock over the water Syn *natural arch, natural bridge*

**sea cave** A cleft or cavity in the base of a sea cliff excavated where wave action has enlarged natural lines of weakness in easily weathered rock. It is usually at sea level and affected by the tides. Syn *marine cave*

**sea cliff** A cliff formed by wave action Syn *wave-cut cliff*

**sea-floor spreading** 1 A process in which the oceanic crust is moving away from a convergent or subducting plate boundary and forming new oceanic crust at a rate of about ten centimeter per year. This movement provides the sea floor dynamics postulated in the hypothesis of *plate tectonics*

**seacell** Any cell formed by pumping from the flowing of seawater (thus excluding icebergs) Cf *iceberg*. A common term for any ice that is floating in the ocean that has drifted to the sea

**sea level** *mean sea level*

**sea level datum** A determination of *mean sea level* that has been adopted as a standard datum for height or elevations based on tidal observations over many years at various tide stations along the coast e.g. the Sea Level Datum of 1929 used by the National Geodetic Survey

**seam** 1 A stratum or bed of coal 2 A plane in a coal bed at which

the different layers are easily separated

**seamount** An elevation of the sea floor, 1000 m or higher, either flat-topped (a *guyot*) or peaked. Seamounts may be either single, arranged in a linear or random grouping, or connected at their bases and aligned along a ridge or rise

**sea stack** *stack*

**seat earth** A British term for a bed of rock underlying a coal seam, representing an old soil that supported the vegetation from which the coal was formed, specif. *underclay*. A highly siliceous seat earth is known as *ganister*

**sea urchin** An *echinoid* having a globular shape and a theca of calcareous plates, commonly with sharp movable spines

**sea wall** 1 A long, steep-faced embankment of shingle or boulders, built by powerful storm waves along a seacoast at the high-water mark. 2 A man-made wall or embankment of stone, reinforced concrete, or other material along a shore to prevent wave erosion

**secondary** (sec'-ond-ai-y) 1 *supergene*. 2 Said of a metal obtained from scrap rather than from ore. 3 Said of a mature shoreline whose features are produced chiefly by present-day marine processes, e.g. wave erosion - Ant *primary*

**secondary consolidation** Consolidation of sediment, at essentially constant pressure, resulting from internal processes such as recrystallization

**secondary crater** A crater produced by the relatively low-velocity impact of fragments ejected from a large *impact crater* e.g. any of several 'splash structures' formed by fragments thrown up from the moon's surface as a result of violent primary impacts

**secondary enlargement** Deposition around a clastic mineral grain, of material of the same composition as that grain and in optical and crystallographic continuity with it, often resulting in crystal faces characteristic of the original mineral e.g. the addition of a quartz overgrowth around a silica grain in sandstone. Cf *rim cementation*

**secondary enrichment** *supergene enrichment*

**secondary mineral** A mineral formed later than the rock enclosing it, usually at the expense of an earlier-formed *primary mineral* as a result of weathering, metamorphism, or solution

**secondary porosity** The porosity developed in a rock after its deposition or emplacement, through such processes as solution or fracturing. Cf *primary porosity*

**secondary recovery** Production of oil or gas as a result of artificially augmenting the reservoir energy, as by injection of water or other fluid. Secondary-recovery techniques are generally applied after substantial depletion of the reservoir. See also *water flooding*

**secondary reflection** *multiple reflection*



**secondary structure** A structure that originated after the deposition or emplacement of the rock in which it is found, e.g. a fault, esp. an epigenetic sedimentary structure, such as a concretion or a sedimentary dike Cf *primary structure*

**secondary wave** *S wave*

**second law of thermodynamics** For all reversible processes, the change in entropy is equal to the heat which the system exchanges with the outside world divided by the absolute temperature. In irreversible processes the change in entropy is greater than the quotient of heat and temperature

**secrehon** (se-cre'-tion) 1 The process by which animals and plants transform mineral material from solution into skeletal forms 2 A secondary structure formed of material deposited from solution within a cavity in a rock, e.g. a mineral vein or a geode Deposition is inward, rather than outward from a center as in a *concretion*

**sectile** (sec'-tile) Said of a mineral that can be cut with a knife, e.g. argentite

**section** (sec'-tion) 1 An exposed surface or cut, either natural (such as a sea cliff) or artificial (such as a quarry face) through a part of the earth's crust. It may be vertical or inclined 2 *columnar section* 3 *type section* 4 *thin section* 5 One of the 36 units of subdivision of a township normally a piece of land one square mile in area

**secular movements** (sec'-u-lar)

Systematic, persistent movements of the earth's crust, either upward or downward, that take place slowly and imperceptibly over long periods of geologic time.

**secular variation** A relatively large slow change in part of the earth's magnetic field caused by the internal state of the planet and having a form roughly to be expected from a simple but not quite uniformly polarized sphere

**sedentary** (sed'-en-tar-y) 1 Attached, as an oyster, barnacle, or similar shelled invertebrate 2 Said of a sediment or soil that is formed in place, without transportation, by disintegration of the underlying rock or by accumulation of organic material

**sedifluction** (sed-i-fluc'-tion) The subaqueous or subaerial movement of material in unconsolidated sediments, occurring in the primary stages of diagenesis

**sediment** (sed'-i-ment) 1 Solid material that has settled down from a state of suspension in a liquid 2 More generally, solid fragmental material transported and deposited by wind, water, or ice, chemically precipitated from solution, or secreted by organisms and that forms in layers in loose unconsolidated form, e.g. sand, mud, till In this sense the term is often used in the plural Cf *deposit*

**sedimentary** (sed-i-men'-ta-ry) Pertaining to or containing sediment, or formed by its deposition

**sedimentary cycle** *cycle of sedi-*

*mentation.*

**sedimentary dike** A tabular mass of sedimentary material that cuts across the structure or bedding of pre-existing rock in the manner of an igneous dike. It is formed by the filling of a crack or fissure by forcible injection of sediments under abnormal pressure (as by gas pressure or by the weight of overlying rocks), or by simple infilling, esp a *clastic dike*.

**sedimentary facies** Any areally restricted part of a designated stratigraphic unit that exhibits characters significantly different from those of other parts of the unit Cf *facies*.

**sedimentary mantle** Sedimentary rocks overlying the crystalline basement

**sedimentary ore** A sedimentary rock of ore grade, an ore deposit formed by sedimentary processes: e.g. saline residues, phosphatic deposits, or iron ore of the *Clinton* ore type.

**sedimentary petrography** The description and classification of sedimentary rocks

**sedimentary petrology** The study of the composition, characteristics, and origin of sediments and sedimentary rocks

**sedimentary rock** A layered rock resulting from the consolidation of sediment e.g. a clastic rock such as sandstone a chemical rock such as rock salt, or an organic rock such as coal. Some authors include pyroclastic rocks, such as tuff

**sedimentary structure** A structure

in a sedimentary rock, formed either contemporaneously with deposition (a *primary structure*) or by later sedimentary processes (a *secondary structure*)

**sedimentary tectonics** Buckling and folding of strata in geosynclinal basins produced by subsidence of the geosyncline

**sedimentary trap** An area between a high-energy and a low-energy environment in which sedimentary materials accumulate.

**sedimentation** (sed'-i-men-ta'-tion)

1 The process of forming sediment in layers, including the separation of rock particles from the parent material, the transportation of these particles to the site of deposition, the actual deposition or settling, the diagenetic changes occurring in the sediment and its ultimate consolidation into rock. 2 Less broadly, the process of *deposition* of sediment, esp by mechanical means from a state of suspension in air or water. 3 *silting up*

**sedimentation curve** An experimentally derived curve showing cumulatively the quantity of sediment deposited or removed from an originally uniform suspension in successive units of time

**sedimentation unit** That thickness of sediment which was deposited under essentially constant physical conditions, a layer or deposit resulting from one distinct act of sedimentation

**sediment concentration** The ratio of the dry weight of the sediment in a water-sediment mixture to

the total weight of the mixture. It is usually expressed in percent for high concentration values, or in parts per million for low values.

**sediment discharge** The amount of sediment moved by a stream in a given time, measured by dry weight or by volume, the rate at which sediment passes a section of a stream.

**sediment load** The solid material transported by a stream, expressed as the dry weight of all sediment that passes a given point in a given period of time.

**sedimentology** (sed'-i-men-tol'-o-gy) The scientific study of sedimentary rocks and of the processes by which they were formed; the description, classification, origin, and interpretation of sediments

**sediment station** A vertical cross-sectional plane of a stream, usually normal to the direction of flow, where samples of suspended load are collected for determining concentration, particle-size distribution, and other characteristics

**seep** *n.* A spot where water or petroleum oozes from the earth, often forming the source of a small trickling stream —*v.* To move slowly through small openings of a porous material.

**segregation** (seg-re-ga'-tion) 1 *magmatic segregation.* 2 A secondary feature formed as a result of chemical rearrangement of minor constituents within a sediment after its deposition, e.g. a nodule of iron sulfide

**segregation banding** A composi-

tional banding in gneisses that is not primary in origin, but rather is the result of segregation of material from an originally more nearly homogeneous rock.

**seiche** (saysh) 1 An oscillation of a body of water in an enclosed or semi-enclosed basin that varies in period, depending on the physical dimensions of the basin, from a few minutes to several hours, and in height from several centimeters to a few meters. It is caused chiefly by local changes in atmospheric pressure, aided by winds, tidal currents, and occasionally earthquakes. 2. A term used in the Great Lakes region for any sudden rise in the water of a harbor or lake

**seif** (safe) A very large, sharp-crested, tapering *longitudinal dune* or chain of dunes, found in the Sahara Desert; its crest in profile consists of a series of peaks and cols, and it bears on one side a succession of curved slip faces produced by strong but infrequent cross winds that tend to increase its height and width. A seif dune may be as much as 200 m high, and from 400 m to more than 100 km long (300 km in Egypt). Etymol Arabic Syn: *seif dune*.

**seif dune** *seif*.

**seism** *earthquake*.

**seismic** (seis'-mic) Pertaining to an earthquake or earth vibration, including those that are artificially induced.

**seismic activity** *seismicity*.

**seismic area** 1 An *earthquake*

**zone 2.** The region affected by a particular earthquake

**seismic belt** An elongate *earthquake zone*, esp a zone of subduction or sea-floor spreading.

**seismic detector** An instrument, e.g. a seismometer or geophone, that receives seismic impulses and converts them into electrical voltage or otherwise makes them evident. Colloquial syn *pot.*

**seismic discontinuity** *discontinuity*

**seismic-electric effect** A phenomenon in which a periodic change in current is caused to flow between two electrodes inserted in the ground when a seismic wave passes through the region between them

**seismic event** An earthquake or a somewhat similar transient earth motion caused by an explosion. Syn *event*

**seismic exploration** The use of artificially generated seismic waves in the search for economic deposits such as salt or oil and gas, or in engineering studies, e.g. determining the depth to bedrock. Syn *seismic prospecting*

**seismic facies analysis** The description and geologic interpretation of seismic reflection patterns, based on reflection configuration, continuity, amplitude, frequency, and interval velocity

**seismic intensity** The average rate of flow of seismic wave energy through a unit cross section perpendicular to the direction of propagation. See also. *sound intensity*

**seismicity** (seis-mic'-i-ty) 1 The likelihood of an area being subject to earthquakes. 2 The phenomenon of earth movements.—Syn *seismic activity*

**seismic map** A contour map constructed from seismic data. Values may be in either time or depth, data may be plotted with respect to the observing station (producing an "unmigrated map") or with respect to the subsurface reflecting or refracting locations (a "migrated map")

**seismic method** A method of geophysical prospecting using the generation, reflection, refraction, detection, and analysis of elastic waves in the earth

**seismic prospecting** *seismic exploration*.

**seismic record** In geophysical prospecting, a photographic or magnetic record of reflected or refracted seismic waves, in earthquake seismology, a record of all seismic activity during a period of time, including background noise and body and surface waves from both natural and artificial events.

**seismic shooting** A method of geophysical prospecting in which elastic waves are produced in the earth by the firing of explosives. See also. *reflection shooting; refraction shooting*

**seismic stratigraphy** The study of stratigraphy and depositional facies as interpreted from seismic data.

**seismic surveying** The gathering of seismic data from an area, the initial phase of seismic prospecting

**seismic velocity** The rate of propagation of an elastic wave, usually measured in km/sec. The wave velocity depends on the type of wave, as well as the elastic properties and density of the earth material through which it travels. Cf. *interval velocity*

**seismic wave** 1 A general term for all elastic waves produced by earthquakes or generated artificially by explosions. It includes both body waves and surface waves. 2 A seismic sea wave, or *tsunami*. Syn. *earthquake wave*

**seismogram** (seis-mo-graph) The record made by a seismograph

**seismograph** (seis'-mo-graph) An instrument that records seismic waves. Cf. *seismometer*, *seismic detector*, *geophone*

**seismologist** (seis-mol'-o-gist) One who applies the methods or principles of seismology, as in earthquake prediction or seismic exploration

**seismology** (seis-mol'-o-gy) The study of earthquakes, and of the structure of the earth, by both natural and artificially generated seismic waves

**seismometer** (seis-mom'-e-ter) seismic detector

**selective fusion** (se-lec-tive) The fusion of only a portion of a mixture such as a rock. The liquid portion will generally contain a larger proportion of the more fusible components than the parent material did. Cf. *anatexis*

**selective replacement** Replacement of one mineral in preference

to, or more rapidly than, another

**selenite** (sel'-e-nite) The clear, colorless variety of gypsum, occurring (esp. in clays) in distinct, transparent monoclinic crystals or in large crystalline masses that easily cleave into broad folia

**selenology** (sel-e-nol'-o-gy) A branch of astronomy that deals with the moon, the science of the moon, including lunar geology

**selenomorphology** (se-le'-no-morphol'-o-gy) "Geomorphology" of the moon, the study of lunar landforms and their origin, evolution, and distribution

**self-potential curve** (self-po-ten'-tial) *spontaneous potential curve*

**self-potential method** An electrical exploration method in which are determined the spontaneous electrical potentials (spontaneous polarization) that are caused by electrochemical reactions associated with clay or metallic mineral deposits. Syn. *spontaneous-potential method*

**selva** (sel'-vage) 1 The altered, clayey material found along a fault zone, *fault gouge*. 2 A marginal zone of a rock mass, having some distinctive feature of fabric or composition, such as the chilled border of a dike which commonly shows a finer grain and sometimes a glassy texture

**SEM** *scanning electron microscope*

**semianthracite** (sem-i-an'-thracite) Coal having a fixed-carbon content of 86% to 92%. It is between bituminous coal and anthracite in metamorphic rank, although its physical properties

more closely resemble those of anthracite

**semiarid** (sem-i-ar'-id) Said of a type of climate in which there is slightly more precipitation (25-50 cm) than in an arid climate, and in which sparse grasses are the characteristic vegetation Syn *sub arid*

**semibituminous coal** (sem-i-bi-tu'-m-nous) Coal that ranks between bituminous coal and semianthracite it is harder and more brittle than bituminous coal It has a high fuel ratio and burns without smoke

**semidiurnal tide** (sem-i-di-ur'-nal) A tide with two high and two low waters in a tidal day

**Senecan** (Sen-e-can) Lower Upper Devonian of North America

**senescence** (se-nes'-cence) 1 That point when a landform or region enters the stage of *old age* Cf *senility* 2 The later stages in the life cycle of a species or other group

**senescent** (se-nes'-cent) 1 Pertaining to the stage in the developmental sequence of a landform, or in the cycle of erosion when the processes of erosion become slow and ineffective esp said of a landscape that is in *old age* 2 Said of a lake that is nearing extinction, as from filling by the remains of aquatic vegetation

**senility** (se-nil'-i-ty) The stage of the cycle of erosion in which erosion has reached a minimum and base level has been approached Cf *old age* *senescence*

**separation** (sep-a-ra-tion) The dis-

tance between two parts of an index plane (e.g. bed or vein) disrupted by a fault See *horizontal separation*, *vertical separation*, *stratigraphic separation*

**sepiolite** (se'-pi-o-lite) A chain-lattice clay mineral,  $Mg_4(Si_2O_5)_3(OH)_2 \cdot 6H_2O$  It is a white to light-gray or light-yellow material, extremely lightweight absorbent and compact that is found chiefly in Asia Minor and is used for making tobacco pipes and ornamental carvings Sepiolite occurs in veins with calcite and in alluvial deposits formed from weathering of serpentine masses Syn *meerschaum*

**septarian** (sep-tar-i-an) Said of the irregular polygonal pattern of internal cracks developed in a *septarium* closely resembling the desiccation structure of mud cracks, also said of the epigenetic mineral deposits that may occur as fillings of these cracks

**septarium** (sep-tar-i-um) A large spheroidal concretion generally of impure limestone or clay ironstone, cut into polyhedral blocks by radiating and intersecting cracks which have been filled (and the blocks cemented together) by a mineral material, generally calcite Its origin involves the formation of an aluminous gel, hardening of the exterior, shrinkage cracking due to dehydration of the colloidal mass in the interior, and vein filling Syn *turtle stone* Pl *septaria*

**septum** 1 One of the transverse internal calcareous partitions divid-

ing the shell of a cephalopod. 2. Any of a variety of wall-like plates or partitions in other invertebrate shells or skeletons, e.g. radially disposed calcareous plates in a corallite Pl *septa* Adj *septal*

**sequence** (se'-quence) 1 A succession of geologic events, processes, or rocks arranged in chronological order 2 A major informal lithostratigraphic unit of greater than group or supergroup rank, traceable over large areas of a continent, and bounded by unconformities of interregional scope as in the cratonic interior of North America, a geographically discrete succession of major rock units that were deposited under related environmental conditions Syn *stratigraphic sequence*

3 A term now obsolete for the rocks formed during an era an *eratherm* 4 A faunal succession

**seral** A sequence of ecologic communities that succeed one another in development from pioneer stage to climax community Adj *seral* See also *succession*

**sericite** (ser'-i-cite) A white, fine-grained potassium mica occurring in small scales and flakes as an alteration product of various aluminosilicate minerals, having a silky luster, and found in various metamorphic rocks (esp schists and phyllites) or in the wall rocks, fault gouge, and vein fillings of ore deposits It is usually muscovite or very close to muscovite in composition, and may also include much illite.

**series** (se'ries) 1 A chronostrati-

graphic unit next in rank below *system* and above *stage*, the rocks formed during an *epoch* of geologic time Some series are worldwide, others provincial 2 A term often misused for an assemblage of formations, esp in the Precambrian The term *group* should be used in this sense 3 *igneous-rock series* 4 *radioactive series*

**serpentine** (ser'-pen-tine) 1 A group of common rock-forming minerals having the formula  $(\text{Mg, Fe})_3\text{Si}_2\text{O}_5(\text{OH})_4$  Serpentes have a greasy or silky luster, a slightly soapy feel, and a tough, conchoidal fracture, they are usually compact but may be granular or fibrous, and are commonly green or greenish gray Serpentes are always secondary minerals, derived by alteration of magnesium-rich silicate minerals (esp olivine), and are found in both igneous and metamorphic rocks Translucent varieties are used for ornamental and decorative purposes 2 A mineral of the serpentine group, such as chrysotile or antigorite—Etymol Latin *serpentinus*, "resembling a serpent", from the mottled shades of green

**serpentine asbestos** *chrysotile*

**serpentine marble** *verd antique*

**serpentinite** (ser'-pen'-ti-nite) A rock consisting almost wholly of serpentine-group minerals e.g. antigorite and chrysotile, commonly derived from the alteration of peridotite Accessory chlorite, talc, and magnetite may be present

**serrate** Said of topographic features that are notched or have a saw-toothed profile, e.g. a *serrate* divide. Etymol: Latin *serra*, "saw".

**sessile** Said of a plant or animal that is permanently attached to a substrate and is not free to move about

**set 1** Two or more consecutive sedimentary beds of the same lithology, separated from strata above and below by surfaces of erosion, nondeposition, or abrupt change in character. 2. Any group of parallel or closely related features, e.g. a *joint set*.

**settling velocity** (set'-ting) The rate at which suspended solids subside and are deposited.

**Sevier orogeny** (Se-vier') The deformations that occurred along the eastern edge of the Great Basin in Utah (eastern edge of Cordilleran miogeosyncline) between the Nevadan orogeny farther west and the Laramide orogeny farther east, culminating early in the Late Cretaceous. During the orogeny, the folding and eastward thrusting of the miogeosynclinal rocks over their foreland was largely completed

**shaded-relief map** A map of an area whose relief is made to appear three-dimensional by the method of *hill shading*.

**shadow zone 1.** A region 100°-140° from the epicenter of an earthquake in which, owing to refraction from the low-velocity zone inside the core boundary, there is no direct penetration of seismic

waves. 2. *wind shadow*.

**shale** A fine-grained detrital sedimentary rock, formed by the compaction of clay, silt, or mud. It has a finely laminated structure, which gives it a fissility along which the rock splits readily, especially on weathered surfaces. Shale is well indurated, but not as hard as argillite or slate. It may be red, brown, black, or gray.

**shale oil** A crude oil obtained from *oil shale* by submitting it to destructive distillation.

**shallower-pool test** A well located within the known limits of an oil or gas pool and drilled with the object of searching for new producing zones above the producing zone of the pool

**shallow-focus earthquake** An earthquake with a focus at a depth of less than 70 km. Most earthquakes are of this type. Cf. *intermediate-focus earthquake*; *deep-focus earthquake*.

**shaly** Pertaining to or having the character of shale, esp its tendency to split readily along closely spaced bedding surfaces. Cf. *argillaceous*.

**Shand's classification** A classification of igneous rocks based on crystallinity, degree of saturation with silica, degree of saturation with alumina, and color index.

**shape-preferred orientation** The preferred orientation of elongated or flattened axes of crystals, as a result of crystal gliding, dynamic recrystallization, or magmatic settling or flow. Cf. *lattice-pre-*



*ferred orientation.*

**shard** A curved, spiculelike fragment of volcanic glass.

**sharpstone** Any rock fragment larger than a sand grain (diameter greater than 2 mm) having angular edges and corners

**shatter cone** A distinctively striated conical fragment of rock along which fracturing has occurred, ranging in length from less than a centimeter to several meters, generally found in nested or composite groups in the rocks of crypto-explosion structures, and generally believed to have been formed by shock waves generated by meteorite impact. Shatter cones superficially resemble cone-in-cone structure in sedimentary rocks; they are most common in fine-grained homogeneous rocks such as limestone and dolomite, but are also known in shale, sandstone, quartzite, and granite. The striated surfaces radiate outward from the apex in horsetail fashion; the apical angle varies but is close to 90 degrees.

**shear** A deformation resulting from stresses that cause contiguous parts of a body to slide relatively to each other in a direction parallel to their plane of contact. It is the mode of failure in which the portion of a mass on one side of a plane or surface slides past the portion on the opposite side. In geological literature the term refers almost invariably to strain rather than to stress. It is also used to refer to surfaces and zones of failure by shear, and to surfaces

along which differential movement has taken place.

**shear cleavage** *slip cleavage.*

**shear fold** A fold model of which the mechanism is shearing or slipping along closely spaced planes parallel to the fold's axial surface. The resultant structure is a *similar fold*. Syn: *slip fold*.

**shear fracture** A fracture that results from stresses that tend to shear one part of a rock past the adjacent part. Cf: *tension fracture*.

**shear joint** A joint that formed as a *shear fracture*.

**shear modulus** *modulus of rigidity.*

**shear strain** A measure of the amount by which parallel lines have been sheared past one another by deformation, specif. the tangent of the change in angle between initially perpendicular lines.

**shear strength** The internal resistance of a body to shear stress, typically including a frictional part and a part independent of friction called *cohesion*.

**shear stress** That component of stress which acts tangential to a plane through any given point in a body; any of the tangential components of the stress tensor.

**shear wave** *S wave.*

**shear zone** A tabular zone of rock that has been crushed and brecciated by many parallel fractures due to shear strain. Such an area is often mineralized by ore-forming solutions. See also: *sheared-zone deposit*.

**sheepback rock** *roche moutonnée.*

**sheet 1.** A tabular igneous intrusion, e.g. a dike or sill. 2. A thin widespread sedimentary deposit, e.g. a *blanket sand*. 3. In a cave, a thin *flowstone* of calcite. 4. *sheetflood*.

**sheeted vein** A group of closely spaced parallel fractures filled with mineral matter and separated by layers of barren rock.

**sheeted-zone deposit** A mineral deposit consisting of veins or lodes filling a zone of shear faulting, or *shear zone*.

**sheet erosion** The removal of thin layers of surface material more or less evenly from an extensive area of gently sloping land, by broad continuous sheets of running water rather than by streams; *rain-wash*. Syn: *slope wash*.

**sheetflood** A broad expanse of moving water that spreads as a thin, continuous film over a large area in an arid region and is not concentrated into well-defined channels; its distance of flow is short and its duration is measured in minutes or hours. Sheetfloods usually occur before runoff is sufficient to promote channel flow, or after a period of sudden and heavy rainfall.

**sheeting** A type of jointing produced by pressure release, or *ex-foliation*. Sheeting may separate large rock masses, e.g. of granite, into tabular bodies or lenses, roughly parallel with the rock surface, that become thicker, flatter, and more regular with depth. It is a useful characteristic of the rock in many quarries. Cf: *pressure-release jointing*; *release joint*.

Syn: *sheet structure*.

**sheet mineral** *phyllosilicate*.

**sheet sand** *blanket sand*.

**sheet structure** *sheeting*.

**shelf 1.** A flat, projecting layer or ledge of rock, as on a slope. 2. A stable cratonic area that was periodically flooded by shallow marine waters and received a thin, well-sorted cover of sediments. Cf: *platform*. 3. *continental shelf*.

**shelf facies** A sedimentary facies that contains sediments produced in the neritic environment of the shelf seas marginal to a low-lying, stable land surface. It is also known as *shelly facies* in recognition of the importance of its characteristic carbonate rocks and fossil shells.

**shelf ice** The ice of an ice shelf. Syn: *barrier ice*.

**shelf sea** A shallow sea situated on the continental shelf, rarely exceeding 150 fathoms (275 m) in depth, e.g. the North Sea.

**shell 1.** The hard, rigid outer covering of an animal, commonly calcareous but sometimes chitinous or siliceous, e.g. the hard parts of an ammonoid. 2. The crust of the earth; also, any of the concentric zones composing the earth's interior. 3. A driller's term for a thin, hard layer of rock encountered in drilling a well. Cf: *shale break*.

**shelly facies** A sedimentary facies that is commonly characterized by abundant calcareous fossil shells, dominant limestones and

dolomites, mature orthoquartzitic sandstones, and paucity of shales. The term is frequently used in reference to lower Paleozoic strata, as in the upper Mississippi Valley and the Great Lakes area. The facies is also known as *shelf facies* in recognition of the presumed structural stability of the site of deposition.

**shield** 1 A large region of exposed *basement* rocks, commonly with a very gently convex surface, surrounded by sediment-covered *platforms*; e.g. Canadian Shield, Baltic Shield. The rocks of virtually all shield areas are Precambrian. Syn: *continental nucleus*. 2. A cave deposit composed of two semicircular plates that form a sandwich separated by a planar crack. Growth occurs at the rim, where water issues from the crack. 3 A protective cover or structure on an animal, e.g. the carapace of a crustacean. 4. A framework of steel or wood, used in tunneling and mining in loose materials. It is moved forward in the process of excavation.

**shield basalt** A basaltic lava flow that erupted from numerous small closely spaced shield-volcano vents, and coalesced to form a single unit. It is generally of smaller extent than a *plateau basalt*.

**shield volcano** A broad, gently sloping volcanic cone of flat domical shape, usually several tens or hundreds of square miles in extent, built chiefly of overlapping and interfingering basaltic

lava flows. Typical examples are the volcanoes Mauna Loa and Kilauea on the island of Hawaii. Syn: *lava dome*; *lava shield*.

**shift** The relative displacement of the units affected by a fault but outside the fault zone itself; partial syn. of *slip*. See also: *strike shift*; *dip shift*.

**shingle** (shin'-gle) Beach gravel which is coarser than ordinary gravel, especially if consisting of flat or flattish pebbles and cobbles. It occurs typically on the higher parts of a beach. The term is more widely used in Great Britain than in the U.S.

**shingle rampart** A ridge of shingle, 1 or 2 meters high, built up by waves on the seaward edge of a reef.

**shingle structure** *Imbricate structure*.

**shoal** adj. Having little depth; shallow.—n. 1. A relatively shallow place in a body of water. 2. A submerged ridge, bank, or bar of sand or other unconsolidated material, rising from the bed of a body of water to near the surface so as to constitute a danger to navigation. It may be exposed at low water. Cf: *reef*.—v. To become shallow gradually; to fill up or block off with a shoal.

**shoal reef** Any formation in which reef growth develops in irregular patches amidst submerged shoals of calcareous reef detritus derived from a large reef. See also: *reef patch*.

**shock breccia** A fragmental rock formed by the action of shock

waves; e.g. *suevite* formed by meteorite impact.

**shock metamorphism** The changes produced in rocks and minerals by the passage of high-pressure shock waves acting over time intervals ranging from a few microseconds to a fraction of a minute. The only known natural mechanism for producing shock-metamorphic effects is the hyper-velocity impact of large meteorites, but the term also includes identical effects produced in small-scale laboratory experiments and in nuclear and chemical explosions. See also: *concussion fracture*.

**shock wave** A compressional wave formed whenever the speed of a body relative to a medium exceeds that at which the medium can transmit sound, having an amplitude that exceeds the elastic limit of the medium in which it travels, and characterized by a disturbed region of small but finite thickness within which abrupt changes occur in the pressure, temperature, density, and velocity of the medium. In rock, it travels at supersonic velocities and is capable of vaporizing, melting, mineralogically transforming, or strongly deforming rock materials. See also: *hyper-velocity impact*.

**shock zone** A volume of rock surrounding an explosion or impact crater in which the effects of shock metamorphism are present.

**shoestring sand** A long, narrow body of sand or sandstone, usual-

ly buried in mud or shale; e.g. a buried sandbar or channel fill. See also: *channel sand*.

**shonkinite** (shon'-kin-ite) A dark-colored syenite composed chiefly of augite and alkali feldspar, and possibly containing olivine, hornblende, biotite, and nepheline. Its name is derived from Shonkin, the Indian name for the Highwood Mountains of Montana.

**shoot** n. 1. *ore shoot*. 2. A rush of water in a rapids; a *chute*. —v. 1. In seismic prospecting, to explore an area, i.e. to set off explosions to generate seismic waves. 2. To set off an explosive charge in a drill hole, at an oil-bearing stratum, for the purpose of increasing the flow of oil.—Etymol: French *chute*.

**shooting star meteor.**

**shoran** (sho'-ran) A system for indicating distance from an airborne or shipborne station to each of two fixed ground stations simultaneously by recording the time required for round-trip travel of radar signals or high-frequency radio waves and thereby determining the position of the mobile station. Its range is effectively limited to line-of-sight distances (about 40 nautical miles). Shoran is used in control of aerial photography, airborne geophysical prospecting, offshore hydrographic surveys, and geodetic surveying for measuring long distances. Cf: *loran*. Etymol: *short-range navigation*.

**shore** The narrow strip of land bordering any body of water; the

most seaward part of the coast. See also: *foreshore*; *backshore*. Syn: *shoreline*.

**shoreface** The narrow zone seaward from the low-tide shoreline, permanently covered by water, over which beach sands and gravels actively oscillate with changing wave conditions.

**shoreline** 1. The intersection of the sea or a lake with the shore or beach; it migrates with changes of the tide or of the water level. The term is frequently used in the sense of "high-water shoreline" or the landward limit of the intermittently exposed shore. Syn: *shore*; *strandline*. 2. The general configuration or outline of the shore.—Cf: *coastline*.

**shoreline cycle** The succession of changes through which coastal features normally pass during the development of a shoreline, from the time when the water first assumed its level and rested against the new shore to the time when the water can do no more work (either erosion or deposition).

**shoreline of depression** A shoreline of submergence that implies an absolute subsidence of the land.

**shoreline of elevation** A shoreline of emergence that implies an absolute rise of the land.

**shoreline of emergence** A shoreline resulting from the dominant relative emergence of the floor of an ocean or lake; the water surface comes to rest against marine-produced forms and structures. The shoreline is straight or gently

curving, with no bays or promontories; it is simpler in outline than a *shoreline of submergence*, and is bordered by shallow water. The term carries no implication as to whether it is the land or the sea that has moved. See also: *shoreline of elevation*. Syn: *negative shoreline*.

**shoreline of submergence** A shoreline resulting from the dominant relative submergence of a landmass; the water surface comes to rest against subaerially produced forms and structures. The shoreline is more irregular in outline than a *shoreline of emergence*, and is bordered by water of variable depth. The term carries no implication as to whether it is the land or the sea that has moved. See also: *shoreline of depression*. Syn: *positive shoreline*.

**shore platform** The horizontal or gently sloping surface produced along a shore by wave erosion; specif. a *wave-cut bench*. Also, sometimes used as a purely descriptive term for *wave-cut platform*.

**shot break** In seismic prospecting, a record of the instant of generation of seismic waves, as by an explosion. Syn. *time break*; *shot instant*.

**shot copper** Small, rounded particles of native copper, molded by the shape of vesicles in basaltic host rock, and resembling shot in size and shape.

**shot depth** In seismic work, the vertical distance from the surface to an explosive charge.

**shot elevation** In seismic prospecting, the elevation of the dynamite charge in the shothole.

**shothole** In seismic prospecting, a borehole in which an explosive is placed for generating seismic waves.

**shot instant** *shot break*.

**shot point** That point at which a charge of dynamite is exploded for the generation of seismic energy. In field practice, the shot point includes the hole and its immediately surrounding area.

**show** 1. A trace of oil or gas detected in a core, cuttings, or circulated drilling fluid, or interpreted from the electrical or geophysical logs run in a well. 2. A small particle of gold found in panning a gravel deposit.

**shrinkage crack** A crack produced in fine-grained sediment by the loss of contained water during drying or dehydration; e.g. a *mud crack*.

**si** In structural petrology, a fabric defined by the preferred orientation of grains within or internal to a porphyroblast. It may or may not be parallel to the preferred orientation of grains outside the porphyroblast. Cf: *se*.

**sial** A petrologic name for the upper layer of the earth's crust, composed of rocks that are rich in silica and alumina; it may be the source of granitic magma. It is characteristic of the upper continental crust. Etymol: an acronym for *silica* + *alumina*. Adj. *sialic*. Cf: *sialma*. Syn: *granitic layer*. **sialma** (si-al'-ma) A layer of the

earth's crust that is intermediate in both depth and composition between the *sial* and the *sima*. Etymol: an acronym for *silica* + *alumina* + *magnesia*.

**side-looking airborne radar** An airborne radar system in which a long, narrow, stabilized antenna, aligned parallel to the motion of an aircraft or satellite, projects radiation at right angles to the flight path. It makes possible extremely fine-resolution photography and mapping of the ground surface. Abbrev: SLAR.

**siderite** (sid'-er-ite) 1. A brownish rhombohedral mineral of the calcite group,  $\text{FeCO}_3$ , commonly containing magnesium and manganese. Siderite is common in beds and nodules of clay ironstone, and is an ore of iron. 2. A general name for meteorites composed almost wholly of iron alloyed with nickel.

**siderolite** (sid'-er-o-lite) *stony-iron meteorite*

**sideromelane** (sid'-er-om'-e-lane) *tachylite*.

**siderophile element** (sid'-er-o-phile) An element that has a relatively weak affinity for oxygen and sulfur and that is readily soluble in molten iron. It is concentrated in iron meteorites and presumably in the earth's inner core. Cf: *chalcophile element*, *lithophile element*.

**siderosphere** (sid'-er-o-sphere) Central iron core of the earth.

**side shot** A reading or measurement from a survey station to locate a point that is off the traverse

or that is not intended to be used as a base for the extension of the survey. It is usually made to determine the position of some object that is to be shown on a map.

**sidetracking** Intentionally deflecting and redrilling the lower part of a borehole away from a previous course; e.g. drilling to the side of and beyond a piece of drilling equipment that is permanently lost in the hole. Cf: *directional drilling*.

**sidewall core** A core or rock sample extracted from the wall of a drill hole, either by shooting a retractable hollow projectile, or by mechanically removing a sample.

**sidewall sampling** The process of obtaining sidewall cores, usually by percussion (shooting hollow retractable cylindrical bullets into the walls).

**sienna** (si-en'-na) Any of various brownish-yellow earthy limonite pigments for oil stains and paints. It becomes orange red to reddish brown when burnt, and is generally darker and more transparent in oils than *ochers*. Named after Siena, a town in Tuscany, Italy. Cf: *umber*.

**sierra** (si-cr'-ra) A high range of hills or mountains, esp. one having jagged or irregular peaks that when projected against the sky resemble the teeth of a saw; e.g. the Sierra Nevada in California. Etymol: Spanish, from Latin *ser-ra*, "saw".

**sieve analysis** Determination of the percentage distribution of particle size by passing a meas-

ured sample of soil or sediment through standard sieves of various sizes.

**sieve texture** A syn. of *poikiloblastic texture*.

**sight** 1. An observation taken for determining direction or position. Also, the data obtained by such an observation; e.g. a bearing taken with a compass when making a survey. 2. A device with a small aperture through which objects are seen and by which their directions are determined; e.g. an "open sight" of an alidade.

**sigillarian** (sig-il-lar'-i-an) n. An arborecent club moss of the genus *Sigillaria* that occurs in Carboniferous deposits.—adj. Pertaining to *Sigillaria*.—Cf: *lepidodendrid*.

**sigmoidal fold** (sig-moi'-dal) A recumbent fold, the axial surface of which is so curved as to resemble the letter S.

**silcrete** 1. A conglomerate consisting of surficial sand and gravel cemented into a hard mass by silica. 2. A siliceous *duricrust*.—Etymol: *siliceous* + *concrete*. Cf: *calcrete*; *ferricrete*.

**silica** (sil'-i-ca) Silicon dioxide, SiO<sub>2</sub>. It occurs as crystalline quartz, cryptocrystalline chalcedony, and amorphous opal; dominantly in sand, diatomite, and chert; and combined in silicates as an essential constituent of many minerals.

**silica sand** An industrial term for a sand or an easily disaggregated sandstone that has a very high percentage of quartz. It is a source

of silicon and a raw material of glass and other industrial products.

**silicate** (sil'-i-cate) A compound whose crystal structure contains  $\text{SiO}_4$  tetrahedra, either isolated or joined through one or more of the oxygen atoms to form groups, chains, sheets, or three-dimensional structures with metallic elements. Silicates are classified according to crystal structure (see *neosilicate*, *sorosilicate*, *cyclosilicate*, *inasilicate*, *phyllosilicate*, *tektosilicate*).

**silicated** (sil'-i-cat-ed) Said of a rock in which the process of *silication* has occurred.

**silication** (sil-i-ca'-tion) The process of converting into or replacing by silicates, esp. in the formation of *skarn* minerals in carbonate rocks. Cf: *silicification*. Adj: *silicated*.

**siliceous** (si-li'-ceous) Said of a rock or other substance containing abundant silica, esp. as free silica rather than silicates.

**siliceous ooze** Any pelagic deep-sea sediment containing at least 30% siliceous skeletal remains, e.g. radiolarian ooze, diatom ooze.

**siliceous residue** An *insoluble residue* chiefly composed of siliceous material, such as quartz or chert.

**siliceous shale** A hard, fine-grained rock of shaly texture with an exceptional amount of silica (as much as 85%). It may have formed by silicification of normal shale, as by precipitation of silica derived from volcanic ash, or by

accumulation of organic material, such as diatom tests, at the time the clay was deposited.

**siliceous sinter** The lightweight porous opaline variety of silica, white or nearly white, deposited as an incrustation by precipitation from the waters of geysers and hot springs. Syn: *sinter*; *geyserite*.

**silicic** (si-lic'-ic) Said of a silica-rich igneous rock or magma. Although there is no firm agreement among petrologists, the amount of silica is usually said to constitute at least 65 percent or two-thirds of the rock. In addition to the combined silica in feldspars, silicic rocks generally contain free silica in the form of quartz. Granite and rhyolite are typical silicic rocks. Syn: *acidic*; *oversaturated*. Cf: *basic*; *intermediate*; *ultrabasic*.

**siliciclastic** (si-li'-ci-clas'-tic) Pertaining to clastic noncarbonate rocks that are almost exclusively silicon-bearing, either as forms of quartz or as silicates.

**silicification** (si-lic'-i-fi-ca'-tion) 1. The introduction of, or replacement by, silica, esp. in the form of fine-grained quartz, chalcedony, or opal, which may fill pores and replace existing minerals. Cf: *silication*. 2. A process of fossilization wherein the original components of an organism are replaced by quartz, chalcedony, or opal.—Adj: *silicified*.

**silicified wood** (si-lic'-i-fied) A material formed by *permineralization* of wood by silica in such a



manner that the original form and structure of the wood is preserved. The silica is generally in the form of opal or chalcedony. Syn: *petrified wood*; *opalized wood*.

**silicon-oxygen tetrahedron** (sil'-i-con-ox'-y-gen) A complex ion formed by four oxygen ions surrounding a silicon ion in a tetrahedral configuration, with a negative charge of 4 units. It is the basic unit of the silicates. It is commonly written as  $\text{SiO}_4$ .

**silky luster** A type of mineral luster characteristic of certain fibrous minerals, e.g. chrysotile.

**sill** 1 A tabular igneous intrusion that parallels the planar structure of the surrounding rock. Cf: *dike*.

2. A submarine ridge at a shallow depth, separating a basin from another basin or from the open sea, e.g. at the Straits of Gibraltar. 3. A ridge at a shallow depth near the mouth of a fjord, separating the deep water of the fjord from the deep ocean water outside. Syn: *threshold*.

**silled basin** A depression in the ocean floor characterized by restricted water circulation often resulting in oxygen depletion. Syn: *barred basin*.

**sillimanite** (sil'-li-man-ite) 1 An orthorhombic mineral,  $\text{Al}_2\text{SiO}_5$ . It is trimorphous with kyanite and andalusite. Sillimanite occurs in long, slender crystals, often as wisplike or fibrous aggregates in schists and gneisses; it forms at the highest temperatures and pressures of a regionally meta-

morphosed sequence and is characteristic of the innermost zone of contact-metamorphosed sediments. 2. A group of aluminum-silicate minerals including sillimanite, kyanite, andalusite, dumortierite, topaz, and mullite.

**silt** 1. A detrital particle finer than fine sand and coarser than clay, commonly in the range of 1/16 to 1/256 mm. 2. A loose aggregate of rock or mineral particles of silt size, commonly with a high content of clay minerals. 3. Mud or fine earth in suspension in water.

**siltstone** An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive *mudstone* in which silt predominates over clay. It tends to be flaggy, containing hard thin layers, and often showing primary current structures.

**Silurian** (Si-lu' ri-an) A period of the Paleozoic, thought to have covered the span of time between 440 and 400 million years ago; also, the corresponding system of rocks. The Silurian follows the Ordovician and precedes the Devonian. It is named after the Silures, a Celtic tribe.

**silver** A soft white mineral, the native metallic element Ag. It is often alloyed with small amounts of gold and other elements. It occurs in stringers and veins and in the upper parts of silver-sulfide lodes.

**sima** (si'-ma [sigh'-ma]) A petrologic name for the lower layer of the earth's crust, composed of rocks that are rich in silica and

**magnesia** It is equivalent to the oceanic crust and to the lower portion of the continental crust, underlying the *sial*. Etymol an acronym for *si*lca + *ma*gnesia. Adj *simatic*. Cf *sialma*. Syn *intermediate layer*; *basaltic layer*.

**similar fold** (sim'-i-lar) A fold in which the orthogonal thickness of the folded strata is greater in the hinge than in the limbs, but the distance between any two folded surfaces is constant when measured parallel to the axial surface. Cf *reverse similar fold*, *concentric fold*.

**simple shear** A homogeneous strain that consists of a movement in one direction of all straight lines initially parallel to that direction. It can be closely approximated by shearing a deck of cards. Cf *pure shear*.

**sinistral** (si-nis' tral) Pertaining, inclined, or spiraled to the left, specif pertaining to the reversed or counterclockwise direction of coiling of some gastropod shells. Ant *dextral*.

**sinistral fault** *left-lateral fault*.

**sinistral fold** An asymmetric fold with the asymmetry of an S as opposed to that of a Z when seen in profile. The long limb appears to be offset to the left. Cf *dextral fold*.

**sink** 1 *sinkhole*. 2 A collapse depression on the flank of a volcano. 3 A depression with no outlet, as where a desert stream comes to an end or disappears by evaporation, e.g. Carson Sink in Nevada.

**sinkhole** A circular depression in a karst area. Its drainage is subterranean, its size is measured in meters or tens of meters, and it is commonly funnel-shaped. Syn *doline*, *sink*. See also *karst valley*.

**sinking** 1 *subsidence*. 2 The downward movement of oceanic surface waters, generally caused by converging currents or by a water mass that becomes denser than the surrounding water. Ant *upwelling*.

**sinter** (sin'-ter) 1 *siliceous sinter*. 2 Calcareous spring deposits, i.e. *tufa* or *travertine*.—Etymol German *Sinter*, "cinder".

**sinus** (si'-nus) A groove, slit, or notch, as developed in the shells of several invertebrates, e.g. a deep reentrant in the outer lip of the aperture of a gastropod shell. Cf *sulcus*.

**siphon** (si'-phon) 1 A water conduit in the shape of an inverted U, in which the water is in hydrostatic equilibrium. 2 A part of a cave passage in which the ceiling dips below water level. See also *sump*. 3 A tubelike organ in some invertebrates for drawing in and ejecting water currents.

**sitting on a well** Working at a well location when the well is being drilled. The geologist examines cuttings and cores, to ascertain what formations are penetrated and to look for signs of hydrocarbons.

**S-joint** *longitudinal joint*.

**skarn** The term is generally reserved for rocks composed mostly

of lime-bearing silicates, derived from nearly pure limestones and dolomites into which large amounts of Si, Al, Fe, and Mg have been introduced. Approx. syn *tactile*.

**skewness** The condition of being disordered or lacking symmetry; specif. the state of asymmetry shown by a *frequency distribution* that is bunched on one side of the average and tails off on the other side. Also, a measure of such asymmetry. Several coefficients of skewness have been devised in an attempt to assign genetic significance to sediment distribution. Cf: *kurtosis*.

**skin friction** 1. The frictional resistance developed between soil and an engineering structure. 2. The shearing resistance of the ground developed on the sides of a pile, pipe, or probing rod. 3. The friction between a fluid and the surface of a solid moving through it.

**slag** 1. A scoriaceous or cindery pyroclastic rock. 2. Material from the iron blast furnace, resulting from the fusion of *fluxstone* with ash from the coke and impurities from the ore. Formerly a solid waste, slag is now utilized, esp. in construction.

**slaking** 1. The crumbling and disintegration of earth materials upon exposure to air or moisture; specif. the breaking-up of dry clay or soil when saturated with or immersed in water. 2. The treating of lime with water to give hydrated (slaked) lime.

**SLAR** *side-looking airborne radar*. **slate** 1. A compact, fine-grained metamorphic rock that possesses *slaty cleavage* and hence can be split into slabs and thin plates. Most slate was formed from shale. 2. A coal miner's term for any shale accompanying coal; also, sometimes the equivalent of *bone coal*.

**slate ribbon** A relict *ribbon* structure on the cleavage surface of slate, consisting of varicolored and straight, wavy, or crumpled stripes. It is generally a trace of bedding.

**slaty cleavage** A parallel foliation of fine-grained, platy minerals, mainly chlorite and sericite, in a direction perpendicular to the direction of maximum finite shortening, developed in slate or other homogeneous rock by deformation and low-grade metamorphism. Most slaty cleavage is also *axial-plane cleavage*. Syn: *flow cleavage*.

**slice** 1. *thrust slice*. 2. An arbitrary inform. division, either of uniform thickness or constituting some uniform vertical fraction, of an otherwise indivisible stratigraphic unit, distinguished for individual facies mapping or analysis.

**slickenside** (slick'-en-side) A polished and striated rock surface that results from friction along a fault plane.

**slide** 1. The movement or descent of a *landslide* or *rockslide*; also, the mass of material so moved. 2. The track of bare rock or fur-

rowed earth left by a landslide.

**slim hole** 1. A rotary borehole having a diameter of 5 in. or less. 2. A drill hole of the smallest practicable size, often drilled with a truck-mounted rig, used primarily for mineral exploration or to obtain stratigraphic or structural information.

**slip** 1. The relative displacement of formerly adjacent points on opposite sides of a fault, measured in the fault surface. Partial syn: *shift*. Syn: *total displacement*. 2. *crystal gliding*.

**slip cleavage** A type of cleavage that is superposed on slaty cleavage or schistosity, and is characterized by finite spacing of cleavage planes between which occur thin, tabular bodies of rock with crenulated cross-lamination. Syn: *shear cleavage*; *strain-slip cleavage*.

**slip face** 1. The steeply sloping surface on the lee side of a dune, standing at or near the angle of repose of loose sand, and advancing downwind by a succession of slides wherever that angle is exceeded. 2. The leeward surface of a sand wave, exhibiting foreset bedding.

**slip fiber** Veins of fibrous minerals, esp. asbestos, in which the fibers are more or less parallel to slickensided vein walls. Cf: *cross fiber*.  
**slip fold** *shear fold*.

**slip-off slope** A gently sloping surface developed along the inner bends of rivers, opposite to the *cutbank*. The surface is the result of lateral and downward erosion

by the river.

**slip sheet** A stratum or rock unit on the limb of an anticline that, having become fractured at its base, has slid down and away from the anticline. It is a gravity-collapse structure.

**slip surface** A landslide displacement surface, often slickensided, striated, and subplanar. It is best exhibited in argillaceous materials and in those materials which are highly susceptible to clay alteration when granulated.

**slip tectonite** A tectonite whose deformation is along the most prominent S planes; a type of *S-tectonite*.

**slope failure** Gradual or rapid downslope movement of soil or rock under gravitational stress, often as a result of man-caused factors, e.g. removal of material from the base of a slope.

**slope stability** The resistance of a natural or artificial slope to failure by landsliding.

**slope wash** Soil and rock material moved down a slope predominantly by the action of gravity assisted by running water that is not confined to channels; also, the process by which such material is moved, specif *sheet erosion*. Cf: *colluvium*.

**slough** 1. A marsh or shallow undrained depression. 2. A sluggish body of water in a tidal flat or bottomland. 3. A piece of soft, muddy waterlogged ground.—Pron: sloo. 4. Rock material that has crumbled from the sides of a borehole; it may obstruct the hole

or be washed out in the drilling mud. Pron shuff

**sluicing** Concentrating heavy minerals, e.g., gold or cassiterite, by washing unconsolidated material through boxes (sluices) equipped with riffles that trap the heavier minerals on the floor of the box.

**slump** 1 The downward slipping of a mass of rock or unconsolidated material, moving as a unit, usually with backward rotation on a more or less horizontal axis parallel to the cliff or slope from which it descends. 2 The sliding-down of a mass of sediment shortly after its deposition on an underwater slope, esp. the down-slope flowage of soft unconsolidated marine sediments at the head or along the side of a submarine canyon. Syn. *subaqueous gliding*. 3 The mass of material produced by a slump, a *slump block*.

**slump bedding** A term applied loosely to any disturbed bedding, specif. deformed bedding produced by subaqueous slumping or lateral movement of newly deposited sediment. See also *convolute lamination*.

**slump block** A coherent mass of material torn away during the formation of a slump; the slide mass remains virtually intact and moves outward and downward.

**slump fault** *normal fault*.

**slump fold** An intraformational fold produced by slumping of soft sediments.

**slurry** A highly fluid mixture of water and finely divided material,

e.g. of pulverized coal and water for movement by pipeline, or of cement and water for use in *grout ing*.

**slush pit** A surface excavation or diked area to impound water or *drilling mud* for use in drilling or to retain fluids discharged from a well.

**smaltite** (smalt'-ite) A tin-white or pale-gray isometric mineral  $(\text{Co}, \text{Ni})\text{As}_3$ . It usually contains some iron, often occurs with cobaltite, and is an ore of cobalt and nickel.

**smectite** (smec'-tite) A group of expanding-lattice clay minerals of the general formula  $\text{R}_{0.33}\text{Al}_2\text{Si}_4\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$ , where R includes one or more of the cations  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{+2}$ ,  $\text{Ca}^{+2}$ , and possibly others. The minerals are characterized by a three-layer crystal lattice (one sheet of aluminum and hydroxyl between two sheets of silicon and oxygen), by deficiencies in charge in the tetrahedral and octahedral positions balanced by the presence of cations (most commonly calcium and sodium) subject to base exchange, and by swelling on wetting, due to introduction of interlayer water in the c-axis direction. The smectite minerals are the chief constituents of *bentonite* and *fuller's earth*, and are common in soils, sedimentary rocks, and some mineral deposits. *Montmorillonite*, formerly used as a group name in the above sense, is now considered a mineral of the smectite group.

**smithsonite** (smith'-son-ite) A mineral of the calcite group,  $\text{ZnCO}_3$ . It is a secondary mineral associated with sphalerite, is commonly reniform, botryoidal, stalactitic, or granular, and is an ore of zinc. Cf: *hemimorphite*.

**smoky quartz** A smoky, brown to gray and often transparent crystalline variety of quartz.

**Snell's law** *law of refraction*.

**snowfield** A region of permanent snow cover, as at the head of a glacier; the *accumulation area* of a glacier.

**snowline** 1. The altitude above which there is permanent snow. 2. *firn line*.

**soapstone** A massive metamorphic rock composed essentially of talc, with varying amounts of micas, chlorite, and other minerals. It may be sawed into laboratory bench tops, switchboards, and the like. 2. A miner's and driller's term for any soft, unctuous rock such as micaceous shale or sericitic schist. 3. *steatite*.

**soda** Sodium carbonate,  $\text{Na}_2\text{CO}_3$ ; especially the decahydrate,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ . Loosely used for sodium oxide, sodium hydroxide, sodium bicarbonate, and even for sodium in informal expressions such as *soda spar*.

**soda ash** Commercial term for sodium carbonate,  $\text{Na}_2\text{CO}_3$ .

**soda feldspar** A misnomer for "sodium feldspar", i.e. *albite*.

**soda lake** An *alkali lake* whose waters contain a high content of dissolved sodium salts, chiefly sodium carbonate accompanied

by the chloride and the sulfate. Examples occur in Mexico and Nevada.

**sodalite** (so'-da-lite) A blue mineral of the feldspathoid group,  $\text{Na}_4\text{Al}_3\text{Si}_3\text{O}_{12}\text{Cl}$ . It occurs in various sodium-rich igneous rocks.

**soda niter** *Chile saltpeter*.

**soda prairie** An extensive level barren tract of land covered with a whitish efflorescence of sodium carbonate (natron), as in parts of SW U.S. and Mexico. Syn: *salt prairie*.

**soda spar** An informal commercial term for sodic feldspar, i.e. *albite*, or for a feldspar mixture assaying at least 7%  $\text{Na}_2\text{O}$ . Syn: *Na-spar*. Cf: *potash spar*.

**sodium bentonite** (so'-di-um) Bentonite in which  $\text{Na}^+$  is the dominant exchangeable ion. Sodium bentonite will absorb large quantities of water, increasing in volume as much as 8 times. It is widely used in oil well drilling muds, in pelletizing pulverized iron ore, and in bonding foundry sands. Syn: *Wyoming bentonite*. Cf: *calcium bentonite*.

**soft coal** *bituminous coal*.

**soft ground** That part of a mineral deposit that can be mined without drilling and blasting. It is usually the upper, weathered portion of the deposit.

**soft rock** 1. A term used loosely for sedimentary rock, as distinguished from igneous or metamorphic rock. 2. Rock that can be removed by air-generated hammers, but cannot be handled economically by pick.—Cf: *hard*

**rock.**

**soft-rock geology** A colloquial term for geology of sedimentary rocks, as opposed to *hard-rock geology*.

**soft water** Water that lathers readily with ordinary soap; water containing not more than 60 mg/l of hardness-forming constituents expressed as  $\text{CaCO}_3$  equivalent. Cf: *hard water*; *hardness*.

**soil 1** The natural medium for the growth of land plants. 2. In engineering geology, all unconsolidated materials above bedrock; i.e. the *regolith*. 3. *lunar regolith*.

**soil creep** The gradual, steady downhill movement of soil and loose rock material on a slope.

**soil horizon** A layer of a soil that is distinguishable from adjacent layers by characteristic physical properties such as structure, color, or texture, or by chemical composition, including content of organic matter or degree of acidity or alkalinity. Soil horizons are generally designated by a capital letter, with or without a numerical annotation, e.g. A horizon, A2 horizon. Syn: *horizon*; *soil zone*.

**soil map** A map showing the distribution of various soil types in an area or region.

**soil mechanics** The application of the principles of mechanics and hydraulics to engineering problems dealing with the behavior and nature of soils, sediments, and other unconsolidated accumulations; the study of the physical properties and utilization of soils, esp. in relation to high-

way and foundation engineering.

**soil profile** A vertical section of a soil that displays all its horizons.

**soil stabilization** Chemical or mechanical treatment designed to increase or maintain the stability of a soil mass or otherwise to improve its engineering properties. Stabilization methods include physical compaction and treatment with cement, lime, and bitumen.

**soil-stratigraphic unit** A soil with physical features and stratigraphic relations that permit its consistent recognition and mapping as a stratigraphic unit.

**soil stripe** A *sorted stripe* whose texture is considerably finer than that of a *stone stripe*.

**soil survey** A general term for the systematic examination of soils in the field and in the laboratory, their description and classification, the mapping of kinds of soil, and the interpretation of soils for many uses, including suitability for growing various crops, grasses, and trees, or for engineering uses, and predicting their behavior under different management systems.

**soil zone** *soil horizon*.

**sol** A homogeneous suspension or dispersion of colloidal matter in a fluid. A sol is in a more fluid form than a *gel*. Cf: *aerosol*. Syn: *colloidal dispersion*.

**solar constant (so'-lar)** The rate at which solar radiant energy is received outside the atmosphere on a surface normal to the incident radiation at the earth's mean dis-

tance from the sun. The value of the mean solar constant is 1.94 gram calories per minute per square centimeter. Cf: *insolation*.  
**solar salt** Crystalline salt obtained by evaporating seawater or other brine by the heat of the sun.

**sole** 1. The undersurface of a rock body or vein, esp. the bottom of a sedimentary stratum. 2. The fault plane underlying a *thrust sheet*. 3. The middle and lower parts of the shear surface of a landslide. 4. The basal ice of a glacier.

**sole fault** A low-angle thrust fault forming the sole of a nappe; also, the basal main fault of an imbricate structure.

**sole injection** An igneous intrusion that was emplaced along a thrust-fault plane.

**sole mark** A directional structure or irregularity on the underside of a bed of sandstone or siltstone along its contact with a finer-grained layer such as shale. Examples: *load cast*; *flute cast*.

**solfatara** (sol-fa-ta'-ra) A type of *fumarole* in which the gases are sulfurous. Etymol: the Solfatara volcano, Italy

**solid flow** Flow in a solid by rearrangement among or within the constituent particles. Cf: *liquid flow*; *viscous flow*.

**solid solution** A single crystalline phase that may be varied in composition within finite limits without the appearance of an additional phase. Syn: *mixed crystal*.

**solidus** (sol'-i-dus) The locus of points on a temperature-composition diagram in a system at tem-

peratures above which solid and liquid are in equilibrium and below which the system is completely solid. In binary systems without solid solutions, it is a straight line; with solid solutions, it is a curved line or a combination of curved and straight lines. In ternary systems, the solidus is a flat plane or a curved surface.

**solifluction** (so-li-fluc'-tion) The slow downslope movement of waterlogged soil, normally at 0.5-5.0 cm/yr; esp. the flow occurring at high elevations in regions underlain by frozen ground that acts as a downward barrier to water percolation, initiated by frost action and augmented by meltwater resulting from alternate freezing and thawing of snow and ground ice. Solifluction is generally more rapid than *soil creep*.

**solifluction lobe** An isolated, tongue-shaped feature, up to 25 m wide and 150 m long, formed by more rapid solifluction on certain sections of a slope showing variations in gradient. It commonly has a steep front and a relatively smooth upper surface.

**solifluction stream** A narrow, laterally confined streamlike deposit of solifluction material.

**solitary coral** (sol'-i-tar-y) A coral that does not form part of a colony; an individual corallite that exists unattached to other corallites. Cf: *colonial coral*. Syn: *cup coral*; *horn coral*.

**solution** (so-lu'-tion) 1. A process of chemical weathering by which mineral and rock material passes



into solution; e.g. removal of the calcium carbonate in limestone by carbonic acid derived from rain-water containing carbon dioxide acquired during its passage through the atmosphere. Syn: *dissolution*. 2. The liquid resulting from such a process.

**solution breccia** A *collapse breccia* formed where soluble material has been removed by solution, allowing the overlying rock to settle and become fragmented; e.g. a breccia consisting of chert fragments from a limestone whose carbonate material has been dissolved away. See also: *evaporite-solution breccia*.

**solution collapse** Abrupt collapse of nonsoluble strata due to the dissolution of soluble underlying rock.

**solution load** *dissolved load*.

**solution mining** 1. The in-place dissolution of mineral components of an ore deposit by permitting a leaching solution, usually aqueous, to trickle downward through the fractured ore to collection galleries at depth. 2. The mining of soluble rock material, esp. salt, from underground deposits by pumping water down wells into contact with the deposit and removing the brine thus created.

**solution transfer** The process of *pressure solution* of detrital grains at points of contact, followed by chemical redeposition of the dissolved material on the less-strained parts of the grain surfaces. See also: *Riecke's principle*. **solution valley** *karst valley*.

**solvus** (sol'-vus) On a phase diagram, the curved line in a binary system, or the surface in a ternary system, that separates a field of homogeneous solid solution from a field of two or more phases that may form from the homogeneous one by exsolution.

**sonar** (so'-nar) An acronym of *sound navigation and ranging*, a method used in oceanography to study the ocean floor.

**sonde** The elongate cylindrical tool assembly used in a borehole to acquire a well log. It is 6 to 40 feet in length and 2 to 6 inches in diameter, and contains various energy-input devices and/or response sensors. The sonde is lowered into the borehole by a multi-conductor cable, or *wire line*.

**sonic log** (son'-ic) An *acoustic log* showing the interval-transit time of compressional seismic waves in rocks near the well bore of a liquid-filled borehole. First used for seismic-velocity information, it is now used chiefly for estimating porosity and lithology. Syn: *velocity log*.

**sonoprobe** (son'-o-probe) A type of echo sounder that generates sound waves and records their reflections from inequalities beneath a sedimentary surface. It is used in subbottom profiling.

**sorosilicate** (so'-ro-sil'-i-cate) A class or structural type of *silicate* characterized by the linkage of two  $\text{SiO}_4$  tetrahedra by the sharing of one oxygen, with a Si:O ratio of 2:7. An example is hemimorphite,  $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$ .

**sorted 1.** Said of a sediment or detrital rock consisting of particles of uniform size or lying within the limits of a single grade. See also: *well-sorted*; *poorly sorted*. Syn: *graded*. **2.** Said of a group of *patterned ground* features displaying a border of stones surrounding sand, silt, or clay.

**sorted circle** A form of *patterned ground* that is dominantly circular and has a sorted appearance commonly due to a border of stones surrounding finer material; developed singly or in groups. Diameter: a few centimeters to more than 10 m; the stone border may be 35 cm high and 8-12 cm wide. Syn: *stone circle*; *stone ring*.

**sorted net** A form of *patterned ground* whose mesh is intermediate between that of a sorted circle and a sorted polygon and has a sorted appearance commonly due to a border of stones surrounding finer material. Diameter: a few centimeters to 3 m.

**sorted polygon** A form of *patterned ground* that is dominantly polygonal and has a sorted appearance due to a border of stones surrounding finer material; never developed singly. Diameter: a few centimeters to 10 m. Syn: *stone polygon*; *stone ring*; *stone net*.

**sorted step** A form of *patterned ground* with a steplike form and a sorted appearance due to a downslope border of stones embanking an area of finer material upslope; formed in groups, rarely if ever singly. Dimensions: 1-3 m wide; up to 8 m long in downslope

direction. See also: *nonsorted step*.

**sorted stripe** One of the alternating bands of finer and coarser material comprising a form of *patterned ground* characterized by a striped pattern oriented down the steepest available slope. It never forms singly, and often exceeds 100 m in length on slopes as steep as 30°. An individual stripe may be a few centimeters to 2 m wide, with the intervening area two to five times wider. See also: *block stripe*; *soil stripe*; *stone stripe*; *striped ground*. \*

**sorting 1.** The process by which sedimentary particles having some particular characteristic (such as size, shape, or specific gravity) are naturally separated from associated but dissimilar particles by the agents of transportation, esp. running water. **2.** The result of the sorting process; the degree of similarity of particles in a sediment. **3.** A measure of sorting, or of the spread of the particle-size distribution on either side of an average.

**sorting index** A measure of the uniformity of particle size in a sediment, usually based on the statistical spread of the particle-size frequency curve.

**sound 1.** A relatively long arm of the sea or ocean, forming a channel between an island and a mainland or connecting two larger bodies, as a sea and the ocean, or two parts of the same body; it is usually wider and more extensive than a strait. **2.** Elastic waves in

which the direction of particle motion is longitudinal, i.e. parallel with the direction of propagation. The term is sometimes restricted to such waves in air and water, but is also applied to wave motion in solids. It is the type of wave motion most often used in the reflection seismograph method of geophysical prospecting.

**sounding** 1. The measurement of water depth taken from a ship. 2. In geophysics, a measurement of how some quantity varies with depth. 3. In engineering, the thickness of soil or the depth to bedrock.

**sounding line** A weighted line, wire, or cord used in sounding.

**sounding sand** Sand, usually clean and dry, that emits a sound when disturbed, such as a desert sand when sliding down the slip face of a dune, or a beach sand when it is stirred or walked over. Examples: *musical sand*; *booming sand*; *whistling sand*.

**sound intensity** *seismic intensity*.

**sour** Said of crude oil or natural gas containing significant fractions of sulfur compounds. Cf *sweet*.

**source-bed concept** The theory of sulfide ore genesis that postulates an original syngenetic deposition of sulfides, and their later migration and concentration, due, for example, to a rise in temperature of the rock.

**source rock** The geological formation in which oil or gas originate.  
**sp. species.**

**space lattice** *crystal lattice*.

**spall** n. A relatively thin curved piece of rock produced by exfoliation—v. To break off in layers parallel to a surface.

**span** 1. The length of a time interval. 2. The continuous length of the crest of a ripple mark, measured at right angles to the observed or inferred flow direction.

**spar** A term loosely applied to any transparent or translucent light-colored crystalline mineral, usually readily cleavable and somewhat lustrous, esp. one occurring as a valuable nonmetallic mineral, e.g. fluorspar (fluorite) or heavy spar (barite).

**sparite** (spar'-ite) 1. A descriptive term for the crystalline transparent or translucent interstitial component of limestone, consisting of clean, relatively coarse-grained calcite or aragonite that either accumulated during deposition or was introduced later as a cement. It is more coarsely crystalline than *micrite*. 2. A limestone in which the sparite cement is more abundant than the micrite matrix.

**sparker** A marine seismic-energy source employing a high-voltage electrical discharge underwater.

**sparry** 1. Pertaining to, resembling, or consisting of *spar*; e.g. "sparry vein". 2. Pertaining to *sparite*, esp. in allusion to the relative clarity, both in thin section and hand specimen, of the calcite cement; abounding in sparite, such as a "sparry limestone".

**spathic** (spath'-ic) Resembling spar, esp. in having good cleav-

age

**spathization** (spath' i za' tion)

Widely distributed crystallization of sparry carbonates such as calcite and dolomite development of relatively large sparry crystals that have good cleavage

**spatter** 1 An accumulation of very fluid pyroclasts coating the surface around a volcanic vent 2 Droplets on the surface of meteorites or even partly fused with the crust

**spatter cone** A low steep-sided cone of *spatter* built by lava fountains along a fissure or around a vent it is usually of basaltic material

**SP curve** *spontaneous potential curve*

**special creation** (spe' shal) The theory strongly supported before the theory of evolution was generally accepted that each species of organism inhabiting the earth was created fully formed and perfect by some divine process

**speciation** (spe' shi a' tion) 1 The production of new species of organisms from pre-existing ones during evolution 2 The sorting of a collection of many fossil or living specimens into groups each of which represents one species

**species** (spe' shies) 1 A group of organisms, either plant or animal, that may interbreed and produce fertile offspring having similar structure, habits, and functions As a fundamental unit in the hierarchy of classification, species ranks next below *genus* The name of a species is a *binomen*.

Abbrev *sp* 2 A mineral distinguished from others by its unique chemical and physical properties —Adj *specific* Pl *species*

**specific absorption** (spe' shif' ic)

The capacity of water bearing material to absorb liquid after removal of free water, the ratio of the volume of water absorbed to the volume of the saturated material It is equal to *specific yield* except when the water bearing material has been compacted due to the weight of overlying rocks

**specific capacity** The rate of discharge of a water well per unit of drawdown commonly expressed in gallons per minute per foot It varies slowly with duration of discharge

**specific gravity** The ratio of the weight of a given volume of a substance to the weight of an equal volume of water

**specific name** 1 The second term of a *binomen*. 2 A less preferred synonym of *binomen*

**specific retention** The ratio of the volume of water that a given body of rock or soil will hold against the pull of gravity to the volume of the body itself It is usually expressed as a percentage Cf *field capacity*

**specific rotation** The angle of rotation of plane polarized light passing through a substance, measured in degrees per decimeter for liquids and solutions and in degrees per millimeter for solids

**specific susceptibility** *mass susceptibility*

**specific yield** The ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass. This ratio is stated as a percentage. Cf. *effective porosity*, *specific absorption*.

**specimen** (spec'-i-men) A sample, as of a fossil rock, or ore of *hand specimen*. Among minerals, it is often restricted to selected or handsome samples such as fine pieces of ore, crystals or fragments of quartz showing visible gold.

**spectral gamma-ray log** (spec'-tral)

The radioactivity-log curves of the intensity of natural gamma radiation within discrete energy bands characteristic of specific radioactive series (uranium-radium-thorium) or isotopes (potassium-40). It is used in correlation where other criteria fail also in uranium exploration where thorium or potassium minerals contribute significantly to total gamma radiation. See also *gamma-ray log*, *neutron-activation log*.

**spectrographic analysis** (spec-tro-graph-ic) Analysis by obtaining the spectrum of a substance and matching lines in the spectrum with known wavelengths of lines in the spectra of the elements. The analysis can be made quantitative by comparing intensities of the spectral lines.

**spectrometer** (spec-trom'-e-ter) A device for measuring intensity of radiation as a function of wavelength.

**spectroscope** (spec'-tro-scope) An

instrument for producing and visually observing a spectrum.

**spectrum** ('spec'-trum) 1. An array of visible light ordered according to its constituent wavelengths (colors) by being sent through a prism or diffraction grating. 2. An array of intensity values ordered according to any physical parameter, e.g. energy spectrum.—Pl. *spectra*. Adj. *spectral*.

**specular hematite** (spe'-u-lar) *specularite*

**specularite** ('spe'-u-lar-ite) A black or gray variety of hematite with a splendent metallic luster, occurring in micaceous or foliated masses or in tabular or disklike crystals. Syn. *specular hematite*.

**speculative resources** (spe'-u-lative) Undiscovered mineral resources that may occur either in known types of deposit in a favorable geological setting where no discoveries have yet been made, or in as-yet-unknown types of deposit that remain to be recognized. Cf. *hypothetical resources*, *identified resources*.

**speleochronology** (spe-le-o-chro-nol'-o-gy) The dating or chronology of a cave's formation, or of its mineral deposits or filling. The dating may be either relative or absolute.

**speleologist** (spe-le-ol'-o-gist) A scientist engaged in speleology. Cf. *spelunker*.

**speleology** (spe-le-ol'-o-gy) The exploration and scientific study of caves, including their genesis, morphology, and mineralogy.

**speleothem** (spe'-le-o-thern) A

mineral deposit formed in a cave by the action of water. See also: *cave onyx*; *dripstone*. Etymol: Greek, "cave deposit".

**spelunker** (spe-lunk'-er) *caver*.

**spengenite** (sper'-gen-ite) A calcarenite that contains oolites and fossil debris (such as bryozoan and foraminiferal fragments) and that has a quartz content not exceeding 10%. Type locality: Spengen Hill, near Salem, Ind. Syn: *Bedford limestone*; *Indiana limestone*.

**spermatophyte** (sper-mat'-o-phyte) A vascular plant that produces seeds, e.g. a gymnosperm or angiosperm; a seed plant. Such plants range from the Carboniferous. Cf: *pteridophyte*.

**spessartine** (spes'-sar-tine) The relatively rare manganese-aluminum end-member of the garnet group,  $Mn_3Al_2(SiO_4)_3$ . Syn: *spessartite*.

**spessartite** (spes'-sar-tite) 1. *spessartine*. 2. A lamprophyre composed of phenocrysts of green hornblende or clinopyroxene in a groundmass of sodic plagioclase, with accessory olivine, biotite, apatite, and opaque oxides.

**sphalerite** (spha'-ler-ite) A yellow, brown, or black isometric mineral,  $(Zn,Fe)S$ , with a highly perfect dodecahedral cleavage and a resinous to adamantine luster. It is a widely distributed ore of zinc, commonly associated with galena in veins and other deposits. Syn: *blende*; *zinc blende*; *blackjack*.

**sphene** A yellow or brown mineral,  $CaTiSiO_5$ . It occurs in monoclinic

crystals as an accessory mineral in granitic rocks and calcium-rich metamorphic rocks. Syn: *titanite*.

**sphenoid** (sphe'-noid) An open crystal form having two nonparallel faces that are symmetrical to an axis of twofold symmetry. It occurs in monoclinic crystals of the sphenoidal class. Cf: *dome disphenoid*.

**spherical coordinates** (spher'-i-cal) A system of three-dimensional coordinates defined by a radius and two angles (like latitude and longitude). In seismic prospecting, the radial distance and angular measures that give the orientation of pulses originating at a point source, such as a shothole.

**spherical weathering** *spheroidal weathering*.

**sphericity** (sphe-ric'-i-ty) The degree to which the shape of a sedimentary particle approaches that of a sphere. Not to be confused with *roundness*.

**spheroid** (sphe'-roid) Any figure differing but little from a sphere; in geodesy, a mathematical figure closely approaching the geoid in form and size, and used as a surface of reference for geodetic surveys.

**spheroidal symmetry** (sphe-roid'-al) *axial symmetry*.

**spheroidal weathering** A form of chemical weathering in which concentric shells of decayed rock (ranging in diameter from 2 cm to 2 m) are successively loosened and separated from a block of rock by water penetrating the bounding joints or other fractures

and attacking the block from all sides. It is similar to the larger-scale *exfoliation* produced usually by mechanical weathering. Syn: *onion-skin weathering*; *concentric weathering*; *spherical weathering*.

**spherulite** (spher-u-lite') 1. A rounded mass of acicular crystals, commonly of feldspar, radiating from a central point. Spherulites may range in size from microscopic to several centimeters in diameter. 2. Any more or less spherical body or crystalline aggregate with a radial internal structure formed in a sedimentary rock, e.g. a carbonate nodule in shale.—Adj: *spherulitic*. Cf: *orbicule*.

**spherulitic** (spher-u-lit'-ic) Said of the texture of a rock composed of numerous spherulites; also, said of a rock containing spherulites. Cf: *orbicular*.

**spicule** (spic'-ule) One of the numerous tiny calcareous or siliceous bodies that serve to stiffen and support the tissues of various invertebrates, esp. the sponges. They are often found in samples of marine sediment and in Paleozoic and Cretaceous cherts.

**spike** The known amount of an isotope added to a sample to determine the unknown amount present in analysis by *isotope dilution*.

**spilite** (spi'-lite) An altered *basalt*, generally vesicular, in which the feldspar has been albitized and is accompanied by chlorite, calcite, epidote, chalcedony, prehnite, or other low-temperature hydrous

crystallization products characteristic of a greenstone. Spilite often occurs as submarine lava flows and exhibits pillow structure. Adj: *spilitic*.

**spine** 1. *volcanic spine*. 2. A projection of the shell surface found on various invertebrates, e.g. a movable calcareous shaft on the test of an echinoid.

**spinel** (spi-nel') 1. A mineral,  $MgAl_2O_4$ . Spinel has great hardness, usually forms octahedral crystals, varies widely in color, and is used as a gemstone. It occurs typically as a product of contact metamorphism of impure dolomitic limestone. 2. An isomorphous series of oxides,  $(Mg, Fe, Zn, Mn)Al_2O_4$ , consisting of spinel, hercynite, gahnite, and galaxite. 3. A member of the spinel series.

**spinning fiber** Asbestos suitable for the manufacture of yarns and textiles.

**S-P interval** In earthquake seismology, the time interval between the first arrivals of longitudinal and transverse waves, which is a measure of the distance from the earthquake source.

**split** A small point of sand or gravel projecting from the shore into a body of water; a fingerlike extension of the beach. Cf: *sand spit*.

**s plane** In structural geology, a non-genetic term for any planar fabric element, e.g. *foliation* or *bedding*. Syn: *s surface*.

**splendent luster** (splen'-dent) A mineral luster of the highest intensity.

**split coal** A type of banded coal that is hard, dull, blocky, and grayish black, with uneven fracture and granular texture. It is defined quantitatively as having more than 5% anthraxylon and more than 30% opaque attritus. Cf *durain*.

**split** A coal seam that is separated from the main seam by a thick parting of other sedimentary rock.

**split spread** A type of seismic spread in which the shot point is at the center of the arrangement of geophones. It is commonly used for continuous profiling and for dip shooting.

**splitting** In taxonomy, the practice of classifying species and genera on the basis of relatively minute differences. A taxonomist known for his preference for finely drawn distinctions is called a "splitter". Cf *lumping*.

**spodumene** (spod' u-mene) A mineral of the clinopyroxene group,  $\text{LiAlSi}_2\text{O}_6$ . It occurs in white to green prismatic crystals, often of great size, esp. in granitic pegmatites. Spodumene is an ore of lithium.

**spoil** Overburden or other waste material removed in mining, quarrying, dredging, or excavating.

**spoil bank** A bank, mound, or other accumulation composed of spoil, e.g. a submerged embankment of waste earth material dredged from a channel and dumped along it.

**sponge** A many-celled aquatic in-

vertebrate belonging to the phylum Porifera and characterized by an internal skeleton composed most frequently of specular opaline silica and less commonly of calcium carbonate. Range, Precambrian to present. Syn *porifera*.

**spontaneous polarization** (spor-ta'-ne-ous) Development of differences in static electrical potential between points in the earth as a result of chemical reactions, differences in solution concentration, or the movement of fluids through porous media. See also *self potential method*.

**spontaneous-potential curve** The *electric log* curve that records changes in natural potential along an uncased borehole. Small voltages are developed between mud filtrate and formation water of an invaded bed, and also across the shale-to-mud interface. These electrochemical components are augmented by an electrokinetic potential (streaming potential) developed when mud filtrate moves toward a formation region of lower fluid pressure. Added to the *resistivity log*, this curve makes up the basic electric log of well-logging practice. Syn *SP curve*, *self-potential curve*.

**spontaneous-potential method** *self-potential method*.

**spore** Any of a wide variety of minute unicellular reproductive bodies or cells that are often adapted to survive unfavorable environmental conditions and that are capable of developing independent-



ly into new organisms. Spores occur as fossils from Silurian to the present.

**spot correlation** In seismology, the correlation of reflections on isolated seismograms by noting similarities in character and interval.

**spot elevation** An elevation shown on a topographic map at a critical point, such as a road intersection, to supplement the map information given by contour lines and bench marks.

**spotted slate** An argillaceous rock in which low-grade metamorphism has caused the growth of incipient porphyroblasts.

**spread** 1. In seismology, the layout of geophone groups from which the data from a single shot are recorded simultaneously. 2. A marsh or shallow water body resulting from the expansion in width of a stream, as where a natural obstruction impedes flow.

**spread correction** A correction for normal movement.

**spring tide** A tide occurring twice each month, at or near the times of new moon and full moon, when the gravitational pull of the sun reinforces that of the moon. It has an unusually large or increased tide range. Cf: *neap tide*.

**spud in** To commence the actual drilling of a well.

**spur** 1. A ridge that projects sharply from the crest or side of a mountain; a hill extending from a prominent range of hills or mountains. 2. *meander spur*. 3. A ridge extending from the shore onto the

continental shelf, or projecting outward from a larger submarine elevation. 4. An artificial obstruction extending outward from the bank of a stream in order to deflect the current or protect the shore from erosion. 5. An underwater ledge or projection from an ice wall or iceberg. 6. A small vein branching from a main one.

**squeeze** v. To inject cement slurry into a well, or to inject fluid under high pressure as in hydraulic fracturing. -- n. 1. The plastic movement of soft rocks in the walls of a borehole. 2. The rapid or gradual closing of a mine working by the displacement of weak floor strata from beneath supporting pillars; also, a mine area undergoing a squeeze.

**squeeze job** The forcing of cement slurry into a borehole, in order to recement a channeled area behind the casing or to close off perforations.

**stable** (sta-'ble) Resistant to chemical change, or decomposing with difficulty; e.g. "stable protobutmen", a plant or animal product, resin or spores, that forms fossil carbonaceous deposits such as amber or cannel coal.

Ant: *labile*.

**stability field** (sta-bil'-i-ty) The range of conditions within which a mineral or mineral assemblage is stable.

**stability series** A grouping of minerals according to their persistence in nature, i.e. to their resistance to alteration or destruction by weathering, abrasion, or post-

depositional solution; e.g. olivine (least stable), augite, hornblende, biotite (most stable). The most stable minerals are those that tend to be at equilibrium at the earth's surface.

**stabilized dune** (sta'-bi-lized) *anchored dune*.

**stable** 1. Said of a constituent of a sedimentary rock that effectively resists mineralogic change and represents an end product of sedimentation, e.g. quartz, chert, zircon. 2. Said of a mature sedimentary rock, e.g. an orthoquartzite, that is composed essentially of silica. 3. Said of a part of the earth's crust that shows neither uplift nor subsidence, or that is not readily deformed. 4. Said of a substance that is not spontaneously radioactive.—Cf.: *unstable*.

**stack** 1. An isolated, pillarlike rocky island, detached from a headland by wave erosion; a *needle* or *chimney rock*. 2. The sum of several seismic traces that have been corrected for moveout and statics.

**stade** A substage of a glacial stage marked by a glacial readvance. Syn: *stadial*.

**stadia** (sta'-di-a) 1. A surveying technique in which distances from an instrument to a *stadia rod* are measured by observing through a telescope the intercept on the rod subtending a small known angle at the point of observation, the distance to the rod being proportional to the rod intercept. The angle is usually defined by two fixed lines in the reticle of the tele-

scope. 2. An instrument used in a stadia survey; esp. an instrument with stadia hairs.—Pl: *stadias*. The term is also used as an adjective in such expressions as "stadia surveying".

**stadial** (sta'-di-al) adj. Pertaining to or formed during a *stade*. —n. *stade*.

**stadial moraine recessional moraine**.

**stadia rod** A graduated rod used with an instrument having stadia hairs to measure the distance from the observation point to the place where the rod is positioned.

**stadia tables** Mathematical tables from which may be found, without computation, the horizontal and vertical components of a reading made with an alidade and stadia rod.

**stage** 1. A chronostratigraphic unit next in rank below *series* and above *substage*, based on biostratigraphic zones considered to approximate time-equivalent deposits; the rocks formed during an age of geologic time. 2. A phase in the development of a cycle of erosion, i.e. the stages of youth, maturity, and old age. 3. A time term for a major subdivision of a glacial epoch; it includes glacial stage and interglacial stage. 4. The height of a water surface above an established datum plane. 5. In a microscope, the platform on which the object to be studied is placed. See also: *universal stage*.

**stalactite** (sta-lac'-tite) 1. A cylindrical or conical deposit of miner-

al matter that hangs from the ceiling of a cave, deposited from drops of water. It is usually composed of calcite. 2. A conical formation of lava hanging from the roof of a lava tunnel, developed by the dripping of fluid lava.—Cf: *stalagmite*.

**stalagmite** (sta-lag'-mīte) 1. A conical deposit of mineral matter that is developed upward from the floor of a cave by the action by dripping water. It is usually composed of calcite. 2. A conical formation of lava that is built up from the floor of a cavity in a lava flow.—Cf. *stalactite*

**standard mineral normative mineral**

**standard parallel** 1. Any parallel of latitude that is selected as a standard axis on which to base a grid system, specif one of a set of parallels of latitude (other than the base line) of the U.S. Public Land Survey system, passing through a selected township corner on a principal meridian, and on which standard township, section, and quarter-section corners are established 2. A parallel of latitude that is used as a control line in the computation of a map projection. 3. A parallel of latitude on a map or chart along which the scale is as stated for that map or chart.

**standard section** A reference section showing as completely as possible a sequence of all the strata in a certain area, in their correct order, thus affording a standard for correlation. It supplements (and sometimes supplants) the

type section, esp. for time-stratigraphic units.

**standard state** A condition in the rocks in which the pressure is the same in all directions at any point, as a result of the weight of the overlying rocks.

**standing wave** A water wave, the wave form of which oscillates vertically between two points or nodes, without progressive movement. Syn: *stationary wave*.

**stand of tide** The time during which there is no appreciable change in the height of the tide; it occurs at high water and at low water, and its duration is generally shorter when the tide range is large and longer when the tide range is small.

**standstill stillstand**

**stanniferous** (stan-nif'-er-ous) Yielding or containing tin, as stanniferous ore.

**star** n. The rayed figure produced in *asterism*. —adj. Said of a mineral, crystal, or gemstone that exhibits asterism; e.g. "star sapphire"

**starved basin** A sedimentary basin in which the rate of subsidence is more rapid than the rate of sedimentation. Sediment thickness is greater at the margins than at the center.

**state-line fault** A tongue-in-cheek term for the discontinuity of geologic structures appearing at the borders of geologic maps of adjacent areas, as at state boundaries, owing to differences in interpretation.

**static metamorphism** (stat'-ic) A

variety of regional metamorphism brought about by the action of heat and solvents at high geostatic pressures, not at pressures induced by orogenic deformation.

**Cf:** *thermal metamorphism*.

**static pressure** Pressure that is "standing" or stabilized because it has attained the maximum possible from its source and is not being diminished by loss.

**static zone** A term suggested for the water zone below the lowest point of discharge, i.e. below the *zone of discharge*, supposedly where there is little or no water movement. This concept is inaccurate, as there is substantial movement below this level in both surface- and ground-water bodies.

**station 1.** A position at which a geophysical observation is made. 2 A point on the earth's surface whose position is determined by surveying methods, e.g. a triangulation station.

**stationary field** (sta'-tion-ar-y) A physical field that does not change with time, e.g. a magnetic field, either artificial or natural.

**stationary wave** *standing wave*.

**staurolite** (stau'-ro-lite) A brown to black orthorhombic mineral:  $(\text{Fe,Mg})_2\text{Al}_3\text{Si}_4\text{O}_{23}(\text{OH})$ . Twinned crystals often resemble a cross (six-sided prisms intersecting at  $90^\circ$  and  $60^\circ$ ). It is a common constituent of rocks such as mica schists and gneisses that have undergone medium-grade metamorphism. **Syn:** *fairy stone*.

**steatite** (ste'-a-tite) 1. A compact,

massive rock consisting chiefly of talc but usually containing much other material; an impure talc-rich rock. See also: *soapstone*. 2. A term originally used as an alternative mineral name for *talc*, often restricted to gray-green or brown massive talc that can be easily carved into ornamental objects. 3. *steatic talc*

**steatite talc** A high-grade variety of talc, suitable for use in electronic insulators. It is the purest commercial form of talc. **Syn:** *steatic*.

**Stebinger drum** (Steb'-in-ger) A delicate vertical-angle adjustment for the vernier on the *Gale alidade*, graduated in hundredths of a revolution.

**S-tectonite** (S-tec'-ton-ite) A tectonite whose fabric is dominated by planar fabric elements caused by deformation, e.g. slate **Cf:** *L-tectonite*, *B-tectonite*.

**steinkern** (stein'-kern) Consolidated mud or sediment that filled the hollow interior of a fossil shell (such as a bivalve shell) or other organic structure. Also, the fossil thus formed after dissolution of the mold. **Etymol:** German *Steinkern*, "stone kernel" **Syn:** *internal cast*. See also: *natural mold*.

**stellate** (stel'-late) Said of an aggregate of crystals in a starlike arrangement; e.g. *wavellite*.

**STEM** *scanning transmission electron microscope*.

**stenohaline** (sten-o-ha'-line) Said of a marine organism that tolerates only a narrow range of salini-

ty. Cf: *euryhaline*.

**step fault** 1. One of a set of parallel, closely spaced faults over which the total displacement is distributed. Cf: *fault zone*. 2. One of a series of low-angle thrust faults in which the fault planes step both down and laterally in the stratigraphic section to lower glide planes. Step faulting is due to variation in the competence of the beds in the stratigraphic section. **step-out** A well drilled at a distance from a producing oil or gas well in an effort to extend the productive limits of a field. Cf: *extension well*.

**steppe** An extensive, treeless grassland area in the semiarid mid-latitudes of southeastern Europe and Asia. It is generally considered drier than the *prairie* which develops in the subhumid mid-latitudes of the U.S.

**steptoe** An isolated hill or mountain of older rock surrounded by a lava flow.

**stereogram** (ster'-e-o-gram) 1. A diagram giving a three-dimensional representation, e.g. a block diagram of geologic structure or a stereographic projection of a crystal. 2. A *stereoscopic pair* of photographs correctly oriented for viewing with a stereoscope.

**stereographic projection** (ster'-e-o-graph'-ic) 1. A perspective, conformal, azimuthal map projection in which meridians and parallels are projected onto a tangent plane, with the point of projection on the surface of the sphere diametrically opposite to the point of

tangency of the projecting plane. Any point of tangency may be selected. Stereographic projections are much used for maps of a hemisphere and for showing patterns of island arcs, mountain arcs, and their associated earthquake epicenters. 2. A similar projection used in optical mineralogy and structural geology, made on an equatorial plane passing through the center of the sphere with the point of projection at the south pole. Syn: *stereogram*.

**stereo net** (ster'-e-o) A term used in structural geology and crystallography for a *Wulff net*.

**stereopair** (ster'-e-o-pair') *stereoscopic pair*.

**stereoscope** (ster'-e-o-scope) A binocular optical instrument for assisting the observer to view two properly oriented photographs or diagrams to obtain the mental impression of a three-dimensional model.

**stereoscopic pair** (ster'-e-o-scop'-ic) An overlapping pair of photographs that, when properly oriented and used with a stereoscope, gives a three-dimensional view of the area of overlap. See also: *stereogram*. Syn: *stereopair*.

**stereoscopic vision** Simultaneous vision with both eyes in which the mental impression of depth and distance is obtained, usually by means of two different perspectives of an object (such as two photographs of the same area taken from different camera stations); the viewing of an object in

three dimensions. Syn: *stereovision*.

**stereovision** (ster'-e-o-vi'-sion) *stereoscopic vision*.

**Sternberg's law** The wearing-away of transported particles is proportional to their weight in water and the distance traveled.

**stibnite** (stib'-nite) A lead-gray mineral,  $\text{Sb}_2\text{S}_3$ . It has a brilliant metallic luster, differs from galena by ease of fusion, and often contains gold and silver. Stibnite occurs in massive forms and in prismatic orthorhombic crystals that show highly perfect cleavage and are striated vertically. It is the principal ore of antimony.

**stiff clay** Clay of low plasticity.

**stilbite** (stil'-bite) A zeolite mineral,  $\text{NaCa}_2\text{Al}_5\text{Si}_{13}\text{O}_{36} \cdot 14\text{H}_2\text{O}$ . It occurs in sheaflike aggregates of monoclinic crystals and also in radiated masses.

**stillstand** 1. Stability of an area of land, as a continent or island, with reference to the earth's interior or mean sea level, as might be reflected by a relatively unvarying base level of erosion between periods of crustal movement. 2. A period of time during which there is a stillstand —Syn: *standstill*.

**stibovite** (sti'-shov-ite) A tetragonal mineral,  $\text{SiO}_2$ . It is a high-pressure, extremely dense polymorph of quartz, produced under static conditions at pressures above about 100 kb and found naturally associated with coesite and only in shock-metamorphosed quartz-bearing rocks. Its

occurrence provides a criterion for meteorite impact.

**stochastic process** (sto-chas'-tic) A process in which the dependent variable is random (so that prediction of its value depends on a set of underlying probabilities) and the outcome at any instant is not known with certainty.

**stock** An igneous intrusion that is less than 40 sq mi (100 sq km) in surface exposure, is usually but not always discordant, and resembles a batholith except in size. Syn: *boss*.

**stockpile** An accumulation of ore, stone, or other mined or quarried material, which provides a steady source of supply for the processing plant. Syn: *surge pile*.

**stockwork** A mineral deposit consisting of a three-dimensional network of planar to irregular veinlets closely enough spaced that the whole mass can be mined. Syn: *stringer lode*.

**Stokes' law** A formula that expresses the rates of settling of spherical particles in a fluid:  $V = Cr^2$ , where  $V$  is velocity (in cm/sec),  $r$  is the particles' radius (in cm), and  $C$  is a constant relating relative densities of fluid and particle, acceleration due to gravity, and the viscosity of the fluid. Cf. *impact law*.

**stomach stone** (stom'-ach) *gastrolith*.

**stone** 1 A general term for rock that is used in construction, either crushed for use as *aggregate* or cut into shaped blocks as *dimension stone*. 2 One of the larger

fragments in a variable matrix of a sedimentary rock. 3. A *stony meteorite*. 4. A cut and polished natural gemstone; a gem or precious stone.

**Stone Age** In archaeology, a cultural level that was originally the first division of the "three-age system", and was subsequently divided into the Paleolithic, Mesolithic, and Neolithic. It is characterized by the use of materials other than metal, e.g. stone, wood, or bone, for technical purposes. Correlation of relative cultural levels with actual age varies from region to region; e.g. this oldest cultural level has been discovered to exist in recent times.

**stone circle** *sorted circle*.

**stone field** *block field*.

**stone line** A line of angular or subangular rock fragments that parallels a sloping topographic surface at a depth of several feet. It crops out in natural and artificial cuts.

**stone net** *sorted polygon*.

**stone polygon** *sorted polygon*.

**stone ring** A syn. of *sorted circle* and *sorted polygon*; the term refers to the circular or polygonal border of stones surrounding a central area of finer material.

**stone stripe** A *sorted stripe* consisting of coarse rock debris, and occurring between wider stripes of finer material. Cf: *block stripe*; *soil stripe*.

**stony-iron meteorite** A general name for relatively rare meteorites containing at least 25% by weight of both nickel-iron and

heavy basic silicates such as pyroxene and olivine; e.g. *pallasite* and *mesosiderite*. Syn: *siderolite*.

**stony meteorite** A general name for meteorites consisting largely or entirely of silicate minerals (chiefly olivine, pyroxene, and plagioclase); e.g. *chondrite* and *achondrite*. Stony meteorites resemble ultramafic rocks in composition, and they constitute more than 90% of all meteorites seen to fall.

**stope** An underground excavation formed by the extraction of ore. Cf: *stoping*.

**stoping** 1. Extraction of ore in an underground mine by working laterally in a series of levels in the plane of a vein. See: *overhand stoping*; *underhand stoping*. 2. *magmatic stoping*.

**storm beach** A low, rounded ridge of coarse gravel, cobbles, and boulders, piled up by powerful storm waves behind or at the inner margin of a beach, above the level reached by normal high spring tides or by ordinary waves.

**storm berm** A low beach ridge marking the upper limit of wave action during storms.

**storm surge** An abnormal, sudden rise of sea level along an open coast during a storm, caused primarily by onshore winds, resulting in water piled up against the coast. It is most severe when accompanied by a high tide. Syn: *storm wave*.

**storm wave** *storm surge*.

**stoos** Said of the side of a hill or

knob that faces the direction from which an advancing glacier or ice sheet moved; facing the upstream side of a glacier, and most exposed to its abrasive action. Etymol: German *stossen*, "to push, thrust". Ant: *lee*.

**stoss-and-lee topography** An arrangement, in a strongly glaciated area, of small hills or prominent rocks having gentle slopes on the stoss side and somewhat steeper, plucked slopes on the lee side; this arrangement is the reverse of *crug and tail*.

**strain** Change in the shape or volume of a body as a result of *stress*; a change in relative configuration of the particles of a substance. Syn: *deformation*.

**strain ellipse** An ellipse in the deformed state that is derived from a circle in the undeformed state.

**strain ellipsoid** An ellipsoid in the deformed state that is derived from a sphere in the undeformed state. The sphere is considered to have unit radius, and the ellipsoid accordingly has principal semi-axes equal in length to the principal strains. Syn: *deformation ellipsoid*.

**strata-slip cleavage** *slip cleavage*.

**strait** A relatively narrow waterway between two larger bodies of water.

**strand** A syn. of *shore* and *beach*; the land bordering any large body of water.

**strandflat** Any wave-cut platform; esp. a low, flat platform up to 65 km wide, extending for many hundreds of kilometers along the

rocky coast of western Norway, supporting thousands of stacks and other small islands.

**strandline** 1. The ephemeral line or level at which a body of standing water, e.g. the sea, meets the land; the shoreline, esp. a former shoreline now elevated above the present water level. 2. A bench, esp. one raised above the present sea level.—See also: *raised beach*.

**strand plain** A prograded shore built seaward by waves and currents, and continuous for some distance along the coast.

**strata** (stra'-ta) Plural of *stratum*.

**strata-bound** Said of a mineral deposit confined to a single stratigraphic unit. The term can refer to a *stratiform* deposit, to variously oriented orebodies contained within the unit, or to a deposit containing veinlets and alteration zones that may or may not be strictly conformable with bedding. Cf: *bedded*.

**strategic materials** (stra-te'-gc) Materials that are vital to the security of a nation, but that must be procured entirely or in large part from foreign sources because the available domestic production will not meet the nation's requirements in time of war; e.g. *strategic minerals*.

**strategic minerals** Minerals that are considered to be *strategic materials*; e.g. chromium- and tin-bearing minerals, quartz crystal, and sheet mica were some of the "strategic minerals" during World War II.

**strath** 1. An extensive terraced



remnant of a broad valley floor that has undergone dissection, e.g., river terrace along a valley wall. 2 A broad valley floor representing a local base level, usually covered by a veneer of alluvium. 3 An elongate broad steep-sided depression on the continental shelf, usually glacial in origin. It is often deeper on its nearshore side.

**stratification** (strat-i-fi-ka'shun) 1

The arrangement of sedimentary rocks in strata, *bedding*. It may be indicated by differences in texture, cementation, color, or composition. 2 Layering in a mass of snow, ice, or ice. 3 The arrangement of the waters of a lake in layers of differing density. See also *density stratification*, *thermal stratification*.

**stratification index** A measure of the "beddedness" of a stratigraphic unit, expressed as the number of beds in the unit per 100 feet of section. It is determined by multiplying the number of beds times 1/ft., and dividing by the unit's thickness in feet. See also *isostratification map*.

**stratified** (strat-i-fied) Formed, arranged, or laid down in layers or strata; esp. said of any layered sedimentary rock or deposit. See also *bedded*.

**stratified drift** Glaciofluvial, glaciolacustrine, or glaciomarine drift, consisting of sorted and layered material deposited by a meltwater stream or settled from suspension in a body of quiet water adjoining a glacier. Cf. *till*.

**stratiform** (strat'-i-form) 1 Said of a special type of *strata-bound* deposit in which the desired rock unit constitutes, or is coextensive with, one or more rock layers, e.g., beds of salt or iron oxide, or layers rich in chromite in a layered igneous complex. Cf. *bedded*. 2 Having the form of a layer or bed, as a "stratiform intrusion". Incorrect spelling "strata-form".

**stratigrapher** (stra-tig'-ra-pher)

One who studies or specializes in stratigraphy.

**stratigraphic classification** (strat-i-graph'-ik)

The arrangement of the sequence of rock strata of the earth's crust into units with reference to the many different characters, properties, or attributes which the strata may possess.

**stratigraphic code** A formulation of generally accepted views on stratigraphic principles, procedures, and practices, designed to obtain the greatest possible uniformity in applying such principles, a systematic collection of rules of formal stratigraphic classification and nomenclature. It is applicable to sedimentary, igneous, and metamorphic rocks.

**stratigraphic control** 1 The influence of stratigraphic features on ore deposition, e.g., ore minerals selectively replacing calcareous beds. Cf. *structural control*. 2 The degree of understanding of the stratigraphy of an area; the body of knowledge that can be used to interpret its stratigraphy or geologic history.

**stratigraphic correlation** The process by which stratigraphic units in two or more separated areas are demonstrated to be mutually correspondent in stratigraphic position, as based on geologic age, lithologic characteristics, fossil content, or any other property, *correlation* in the usual or narrowest sense Unless otherwise stated, the term usually implies equivalence in age See also: *lithologic correlation*.

**stratigraphic facies** Facies distinguished primarily on the basis of form, nature of boundaries, and mutual relations, to which appearance and composition are subordinated These facies are all stratigraphic bodies of one kind or another They may occur in vertical succession, with boundaries that are more or less horizontal stratigraphic planes, they may be laterally intergrading parts of a stratigraphic unit, separated at more or less arbitrary vertical cut-off boundaries, or they may bear both lateral and vertical relations to each other and have irregular boundaries. See also *facies*. Cf. *petrographic facies*.

**stratigraphic geology** *stratigraphy*

**stratigraphic interval** The body of strata between two stratigraphic markers.

**stratigraphic leak** The deposition of sediments and/or fossils of a younger age within or under rocks of an older age It frequently involves microfossils, such as conodonts, which have descended through crevices or solution chan-

nels to lodge in a lower stratum where they become associated with fossils of greater age.

**stratigraphic map** A map that shows the areal distribution, configuration, or aspect of a stratigraphic unit or surface. It involves a span of geologic time Examples include isopach map, structure-contour map, facies map, and vertical-variability map.

**stratigraphic paleontology** The study of fossils and of their distribution in various geologic formations, emphasizing the stratigraphic relations (time and sequence) of the sedimentary rocks in which they are contained Cf. *biostratigraphy*.

**stratigraphic range** The distribution or spread of any given species, genus, or other taxonomic group of organisms through geologic time, as indicated by its distribution in strata whose geologic age is known. Also, the persistence of a fossil organism through the stratigraphic sequence. Syn. *range*, *geologic range*.

**stratigraphic separation** The thickness of the strata that originally separated two beds brought into contact at a fault

**stratigraphic sequence** A chronological succession of sedimentary rocks from older below to younger above, essentially without interruption, e.g. a *sequence* of bedded rocks of interregional scope, bounded by unconformities.

**stratigraphic terminology** The unit terms used in stratigraphic classification, such as *formation*,

*stage, biozone.*

**stratigraphic test** A hole drilled to obtain information on the thickness, lithology, sequence, porosity, and permeability of the rock penetrated, or to locate the position of a key bed. It is frequently drilled to evaluate a potentially productive oil or gas zone. Cf: *structure test*.

**stratigraphic trap** A trap for oil or gas that is the result of lithologic changes rather than structural deformation. See also: *pinch-out*. Cf: *structural trap*.

**stratigraphic unit** A stratum or body of strata recognized as a unit for description, mapping, or correlation. Rocks may be classified stratigraphically on the basis of lithology (lithostratigraphic units), fossil content (biostratigraphic units), age (chronostratigraphic units), or properties (such as mineral content or radioactivity) in categories for which formal nomenclature is lacking. A geologic-time unit is not a stratigraphic unit.

**stratigraphy** (stra-tig'-ra-phy) 1. The science of rock strata. It is concerned with all characters and attributes of rocks as *strata*; and their interpretation in terms of mode of origin and geologic history. All classes of rocks, consolidated or unconsolidated, fall within the general scope of stratigraphy. Syn: *stratigraphic geology*. 2. The arrangement of strata, esp. as to geographic position and chronologic order of sequence. 3. The sum of the characteristics

studied in stratigraphy; the part of the geology of an area or district pertaining to the character of its stratified rocks.

**stratosphere** (strat'-o-sphere) The outer layer of the atmosphere, overlying the *troposphere*.

**stratotype** (strat'-o-type) The original, or subsequently designated, type representative of a named stratigraphic unit, or of a stratigraphic boundary identified as a point in a specific sequence of rock strata. It constitutes the standard for the definition and recognition of that unit or boundary. See also: *type section*; *boundary stratotype*.

**stratovolcano** (strat'-o-vol-ca'-no) A volcano that is constructed of alternating layers of lava and pyroclastic deposits, along with abundant dikes and sills. Viscous, acidic lava may flow from fissures radiating from a central vent, from which pyroclastics are ejected. Syn: *composite cone*.

**stratum** (stra'-tum) A layer of sedimentary rock, visually separable from other layers above and below; a *bed*. The term is frequently used in its plural form, *strata*. Cf: *lamina*.

**streak** The color of a mineral in its powdered form, usually obtained by rubbing the mineral on a streak plate and observing the mark it leaves. Streak is an important characteristic in mineral identification.

**streak plate** In mineral identification, a piece of unglazed porcelain used for rubbing a sample to ob-

tain its powder color, or *streak*. It has a hardness of about seven.

**stream capture** *piracy*

**streamflood** A flood of water in an arid region, characterized by the spasmodic flow of a *sheetflood* but confined to a definite, shallow channel that is normally dry.

**stream frequency** Ratio of the number of streams of all orders within a drainage basin to the area of that basin, a measure of topographic texture.

**stream gaging** Measurement of the velocity of a stream of water in a channel or open conduit and of the cross-sectional area of the water, in order to determine *discharge*.

**stream gradient** The angle between the water surface (of a large stream) or the channel floor (of a small stream) and the horizontal measured in the direction of flow, the "slope" of the stream. See also *law of stream gradients*.

**streaming flow** Glacier flow in which the ice moves without cracking or breaking into blocks, as where the walls and bottom are relatively smooth for a long distance.

**streamline flow** *laminar flow*

**stream load** 1. All the material that is transported by a stream, either as visible sediment or in solution. 2. The quantity or amount of such material at any given time or passing a point in a given period, and expressed as a weight or volume per unit time. -Material in solution is sometimes excluded in the usage of the term. See also *sus-*

*pended load, bed load, dissolved load*

**stream order** A classification of the relative position of streams in a channel network, assigning each *link* an integer order number determined by the pattern of confluences in the tributary network headward of the given link. It is used in analysis of erosional topography. See also *basin order, stream segment*.

**stream segment** A *link*, or sequence of links, along a stream channel, extending from the fork where the stream achieves a given stream order to the downstream fork where it joins a stream of equal or higher order.

**stream terrace** One of a series of level surfaces in a stream valley, flanking and more or less parallel to the stream channel. It is above the level of the stream, and represents the dissected remnants of an abandoned flood plain, stream bed or valley floor produced during a former stage of erosion or deposition. See also *rock terrace*. Syn. *terrace, river terrace*.

**stream tin** Cassiterite occurring as water-worn pebbles in alluvial or placer deposits or on bedrock along streams, such as that resulting from the wearing away of pneumatolytic veins associated with acid rocks. Cf. *lode tin*.

**strength** A term used in experimental structural geology that is meaningful only when all the environmental conditions of the experiment are specified, in general, the ability to withstand differen-

real stress measured in units of stress

**stress** In a solid, the force per unit area acting on any surface within it and variously expressed as pounds or tons per square inch or dynes or kilograms per square centimeter, also, by extension, the external pressure which creates the internal force Cf *strain* See also *normal stress*, *shear stress*, *stress difference* The difference between the greatest and least of the three principal stresses

**stress ellipsoid** A geometric representation of the state of stress at a point that is defined by three mutually perpendicular principal stresses and their intensities

**stretching** In metamorphic rocks the elongation of mineral grains as bubbles, or other features, a type of lineation

**stria** 1 One of a series of parallel straight lines on the surface of a crystal, as in pyrite, indicative of an oscillation between two crystal forms, also, one of a series of such lines on the cleavage planes of a mineral, as of plagioclase, indicative of polysynthetic twinning. Syn *striation* 2 One of a series of fine grooved lines or threads on the surface of some shells, e.g. on nautiloid and ammonoid conchs — Adj *striate* Pl *striae* (stri'-ae) Plural of *stria*

**striation** (stri-a'-tion) 1 *stria*. 2 One of multiple scratches or minute lines, generally parallel, inscribed on a rock surface by a geomorphic agent, e.g. glaciers (*glacial striation*) streams (cf *drag marks*)

or faulting, cf *slickenside*) 3

The condition of being striated the disposition of striations —

Adj *striated* *striate*

**striding level** A spirit level so mounted that it can be placed above and parallel with the horizontal axis of a surveying instrument and so supported that it can be used for precise leveling of the horizontal axis of the instrument

**strike** 1 The direction taken by a structural surface, e.g. a bed-ding or fault plane as it intersects the horizontal Cf *trend* 2 The discovery of a mineral deposit esp if sudden or unexpected — v 1 To be aligned or to trend in a direction at right angles to the direction of *dip* 2 To discover or reach a mineral deposit suddenly or unexpectedly e.g. to "strike" oil

**strike fault** A fault that strikes parallel with the strike of the strata involved Cf *dip fault*, *oblique fault*

**strike joint** A joint that strikes parallel to the strike or lineation of the enclosing rock Cf *dip joint*

**strike-overlap** Truncation of sedimentary rocks below unconformities, esp a slow, extremely low-angle region of truncation of contrasting depositional strike below a regional unconformity The term is essentially synonymous with *overstep* if it is assumed that angular unconformities eventually pass downdip into disconformities which in turn disappear farther out in the basin

**strike separation** In a fault, the distance or *separation* of two formerly adjacent beds on either side of the fault surface, measured parallel to the strike of the fault Cf *dip separation*, *strike slip*

**strike shift** The *shift* or relative displacement of the rock units parallel to the strike of a fault, but outside the fault zone itself, a partial syn of *strike slip*

**strike-slip fault** *strike-slip fault*

**strike slip** The component of the movement or *slip* that is parallel with the strike of a fault Cf *dip slip*, *strike separation*, *strike shift*

**strike-slip fault** A fault on which the movement is parallel to the fault's strike Cf *dip-slip fault* See also *transcurrent fault* Syn *strike shift fault*

**strike valley** A valley eroded in, and parallel to the strike of, underlying weak strata It is occupied by a *subsequent stream*

**string 1** A syn of *drill string* 2 The casing, tubing, or pipe, of one size, used in a well

**stringer 1** A mineral veinlet or filament, usually one of many, occurring in a discontinuous subparallel pattern in host rock 2 A thin sedimentary bed, e.g. of coal 3 In seismic prospecting, a thin high-speed layer, usually with limited lateral continuity

**stringer lode** A zone of shattered host rock containing a network of stringers, a *stockwork*

**strip 1** To remove overburden preparatory to quarrying 2 To remove coal or other desired material in open-cut mining

**stripe** One of the alternating bands of fine and coarse surficial material comprising a form of *patterned ground*. See *sorted stripe*, *non-sorted stripe*

**striped ground** A form of *patterned ground* marked by alternating stripes produced on a sloping surface by frost action See also *sorted stripe*

**strip log sample log**

**strip mining** *open-cut mining*

**stripped plain** A plain underlain by flat-lying or gently tilted sedimentary rocks from which sediments have been removed down to a resistant bed that has controlled the depth of erosion Syn *stripped surface*, *structural plain*

**stripped surface** *stripped plain*

**stromatoporoid** (stro-ma-top'-o-roid) A general name for any of a group of extinct sessile benthic marine organisms of uncertain biologic affinities (probably phylum Porifera, possibly Coelenterata or Cyanophyta) They secreted a calcareous skeleton, generally a few tens of centimeters across, of tabular, encrusting, domal or bulbous form Stromatoporoids were especially abundant in Ordovician-Devonian reefs Range, Cambrian(?) to Cretaceous

**Strombolian-type eruption** (Strom-bo'-li-an) A type of volcanic eruption characterized by jetting of clots or "fountains" of fluid basaltic lava from a central crater Etymol Stromboli, Lipari Islands of Italy Cf *Hawaiian-type eruption*, *Peléan-type eruption*, *Vulcanian-type eruption*

**strontianite** (stron'-ti-an-ite) An orthorhombic mineral of the aragonite group,  $\text{SrCO}_3$ .

**structural** (struc'-tur-al) Of or pertaining to rock deformation or to features that result from it.

**structural basin** A tectonically depressed region of the earth's crust. See *basin*.

**structural control** The influence of structural features on ore deposition, e.g. ore minerals filling fractures. Cf. *stratigraphic control*.

**structural crystallography** Study of the internal arrangement and spacing of atoms and molecules composing crystalline solids.

**structural feature** A feature produced by deformation or displacement of the rocks, such as a fold or fault. For such features the more colloquial term *structure* is now generally accepted.

**structural geology** The branch of geology that deals with the description, representation, and analysis of *structures*, chiefly on a moderate to small scale. The subject is similar to *tectonics*, but the latter is generally used for the broader regional or historical phases.

**structural high** *high*.

**structural low** *low*.

**structural petrology** The analysis of fabric on the thin-section or micro scale, including the study of grain shapes and relationships and of crystallographic preferred orientations. Syn. *petrofabric analysis*, *microtectonics*.

**structural plain** *stripped plain*.

**structural relief** 1 The vertical dis-

tance between stratigraphically equivalent points at the crest of an anticline and in the trough of an adjacent syncline. 2 More generally, the difference in elevation between the highest and lowest points of a bed or stratigraphic horizon in a given region.

**structural terrace** 1 A local shelf or steplike flattening in otherwise uniformly dipping strata. 2 A terracelike landform controlled by the structure of the underlying rocks, esp. one produced by the removal of weaker strata from more resistant rocks in a formation with horizontal bedding.

**structural trap** A trap for oil or gas that is the result of folding, faulting, or other deformation. Cf. *stratigraphic trap*.

**structure** (struc'-ture) 1 The attitude and relative positions of the rock masses of an area, the sum of *structural features* resulting from such processes as faulting, folding, and igneous intrusion. 2 In petroleum geology, any physical arrangement of rocks, such as an anticline or reef, that may hold an accumulation of oil or gas. 3 In geomorphology, a general term for the assemblage of rocks underlying a landscape. 4 The form assumed by a mineral, e.g. bladed structure. 5 *crystal structure*. 6 A megascopic feature of a rock generally best seen on the outcrop rather than in hand specimen, e.g. bedding or foliation. Cf. *texture*.

**structure contour** A line drawn through points of equal elevation

on a stratum, key bed, or horizon, in order to depict the attitude of the rocks.

**structure section** A diagram that shows the observed geologic structure on a vertical or nearly vertical surface, or, more commonly, one that shows the inferred structure as it would appear on a vertical plane cutting through a part of the earth's crust. The vertical scale is often exaggerated.

**structure test** A generally shallow hole drilled primarily to obtain information on geologic structure, although other types of information may be acquired during drilling. It is frequently drilled to a structural datum that is above a known or expected oil-producing zone. Cf. *stratigraphic test*.

**sturzstrom** (sturzh'strom) A huge mass of rapidly moving rock debris and dust, derived from the collapse of a cliff or mountain side, flowing down steep slopes and across low ground, often for several kilometers at speeds of more than 100 km/hr. Sturzstroms are the most catastrophic of all forms of mass movement. Several have been identified on the moon. Cf. *rockfall*. Etymol. German 'fall stream'.

**stylolite** (sty'-lo-lite) A surface of contact, usually in carbonate rocks, that is marked by an irregular, interlocking penetration of the two sides, columns, pits, and teeth-like projections on one side fit into their counterparts on

the other. As usually seen in cross section, it resembles a suture or the tracing of a stylus. Stylolites are supposedly formed diagenetically by differential movement under pressure, accompanied by solution. See also *microstylolite*.  
**subaerial** (sub-ae'-ri-al) Formed existing, or taking place on the land surface, contrasted with *subaqueous*.

**subage** A geologic time unit shorter than an age, corresponding to the time-rock unit *substage*.

**subalkalic** (sub-a'-ka-lic) 1. A group term applied to rocks of the tholeiitic and calc-alkaline series. 2. Said of an igneous rock that contains no alkali minerals (the other feldspars). 3. Used to describe an igneous rock of the *Pacific suite*.

**subaluminous** (sub-a-lu-mi-nous) In the Shand classification of igneous rocks, a division embracing those rocks in which there is little or no excess of aluminum oxide over that required to form feldspars or feldspathoids. Cf. *peralkaline*, *peraluminous*, *metaluminous*.

**subangular** (sub-an-gu-lar) Said of a sedimentary particle showing effects of slight abrasion, retaining its original general form, and having faces that are virtually untouched and edges and corners that are rounded off to some extent. Also, said of the *mundness class* containing subangular particles.

**subaqueous** (sub-a'-que-ous) Said of conditions, processes, or



deposits that are situated under water, esp. fresh water, as in a lake or stream Cf. *subaerial*  
**subaqueous gliding** *Subsifflung* or slump under water

**subarctic** (sub-arc'-tic) Pertaining to the regions directly adjacent to the Arctic Circle, or to areas that have climate, vegetation, and animals similar to those of arctic regions

**subarid** (sub-ar'id) *semiarid*

**subarkose** (sub-ar'kose) A sandstone that does not contain enough feldspar to be classed as an *arkose*; one that is intermediate in composition between arkose and pure quartz sandstone

Precise definitions vary. Approx. syn. *feldspathic sandstone*

**subautomorphic** (sub-au-to-mor'phic) Said of the texture of an igneous or metamorphic rock characterized by crystals only partly bounded by their own rational faces; a syn. of *subhedral* in European usage. Syn. *hypidiomorphic* Cf. *automorphic xenomorphic*

**subbituminous coal** (sub-bit'u'-n'-ous) A black coal intermediate in rank between lignite and bituminous coal. It is distinguished from lignite by higher carbon and lower moisture content. Further classification of subbituminous coal is made on the basis of calorific value.

**subcapillary interstice** (sub-cap'il-lar'y) An opening sufficiently smaller than a *capillary interstice* that water held in it by adhesive forces is immovable except by

forces in excess of pressures commonly found in subsurface water Cf. *super-capillary interstice*

**subcrop** An occurrence of strata in contact with the undersurface of a stratigraphic unit that succeeds an unconformity on which *overstep* is conspicuous at subsurface outcrop. That describes the areal limits of a truncated rock unit at a buried surface of unconformity. The term is in common use in petroleum geology.

**subduction** (sub-duc'-tion) The process of one lithospheric plate descending beneath another. A related concept was originally used by Alpine geologists. See also *subduction zone*.

**subduction zone** A long, narrow belt in which *subduction* takes place, e.g. along the Peru-Chile trench, where the Pacific plate descends beneath the South American plate.

**subfacies** (sub-fa'-cies) A subdivision of a facies, as of a broadly defined sedimentary facies, or of a metamorphic facies, based on compositional differences rather than pressure-temperature relations.

**subgenus** (sub-ge'-nus) In the hierarchy of classification of plants and animals, a subcategory of *genus*. The name of a subgenus is placed in parentheses after the genus name and is followed by the name of the species, e.g. *Palaeonella* (*Koenenia*) *emarginata*. Pl. *subgenera*.

**subglacial** (sub-gla'-cial) 1. Formed or accumulated in the

bottom parts of a glacier; said of meltwater streams, till, moraine, etc. Syn: *infraglacial*. 2. Pertaining to the area immediately beneath a glacier.

**subgraywacke** (sub-gray'-wacke)

A sedimentary rock that has less feldspar and more and better-rounded quartz grains than *graywacke*; precise definitions vary. It is the most common type of sandstone, intermediate in composition between graywacke and *orthoquartzite*; it is lighter-colored and better-sorted, and has less matrix, than graywacke.

**subgroup** A formally differentiated assemblage of formations within a *group*.

**subhedral** (sub-he'-dral) 1. Said of a mineral grain that is bounded partly by its own *rational faces* and partly by surfaces formed against pre-existing grains as a result of either crystallization or recrystallization. 2. Said of the shape of such a crystal.—Cf. *euhedral*, *anhedral*.

**subadjacent** (sub-ja'-cent) 1. Said of a stratum situated immediately under a higher stratum or below an unconformity; underlying. Ant: *superjacent*. 2. Said of an igneous intrusion, generally discordant and without a known floor, that presumably enlarges downward to an unknown depth.

**sublimation** (sub-li-ma'-tion) 1. The transition of a substance directly from the solid state to the vapor state, or vice versa, without passing through an intermediate liquid stage. Cf. *evaporation*. 2.

The process of ore deposition, as of sulfur or mercury, by vapors, esp. around *fumaroles*.

**sublittoral** (sub-lit'-to-ral) Said of that part of the littoral zone that is between low tide and a depth of about 100 m. Cf: *neritic*.

**submarginal resources** (sub-mar'-gi-nal) Low-grade resources that are recoverable at prices more than 1.5 times those prevailing now, i.e. are of lower grade than *paramarginal resources*.

**submarine canyon** (sub'-ma-rine)

1. A steep-sided, V-profile trench or valley winding along the continental shelf or continental slope, having tributaries and resembling a river-cut land canyon. 2. A general term for all valleys of the deep-sea floor.

**submarine delta** A sedimentary deposit formed at the mouth of a submarine canyon, whose surface features resemble those of a sub-aerial delta.

**submature** (sub-ma-ture') 1. Said of a topographic feature that has passed through the stage of youth but is not yet at maturity. 2. Said of a sediment characterized by little or no clayey material and by poorly sorted and angular grains, intermediate between *immature* and *mature*.

**submergence** (sub-mer'-gence) A rise of the water level in relation to the land, so that areas formerly dry land become inundated; it results either from a sinking of the land or from a net rise of the water level. Ant: *emergence*.

**submersible** (sub-mers'-i-ble) A

small self-propelled underwater vehicle for direct sea-floor observation and sampling.

**submetallic luster** (sub-me-tal'-lic)

A mineral luster between metallic and nonmetallic. Chromite, for example, has a metallic to submetallic luster.

**subrounded** Said of a sedimentary particle showing considerable abrasion and an original general form that is still discernible, and having many of its edges and corners noticeably rounded off to smooth curves. Also, said of the *roundness class* containing subrounded particles.

**subsequent** (sub'-se-quent) adj. 1.

Said of a post-*consequent* geologic or topographic feature whose development is controlled by differences in the erosional resistance of the underlying rocks, e.g. a subsequent valley developed along the strike of a weakly resistant homoclinal bed. 2. Said of a stream, valley, or drainage system that is developed independently of, and subsequent to, the original relief of a land area, as by shifting of divides or adjustment to rock structure.—n. *subsequent stream*.

**subsequent stream** A tributary

that has developed its valley along a belt of underlying weak rock and is therefore adjusted to the regional structure; esp. a stream that flows in a *strike valley* and that is subsequent to the formation of the stream of which it is a tributary.

**subsidence** (sub-sid'-ence) 1. Sinking or downward settling of the

earth's surface, not restricted in rate, magnitude, or area involved. Subsidence may be caused by natural geologic processes, such as solution, compaction, or withdrawal of fluid lava from beneath a solid crust; or by man's activity, such as subsurface mining or the pumping of oil or ground water. See also: *cauldron subsidence*. 2. A gradual sinking or downward warping of a large part of the earth's crust relative to its surrounding parts, such as the formation of a rift valley or the lowering of a coast due to tectonic movements.—Syn: *sinking*.

**subsolidus** (sub-sol'-i-dus) A chemical system that is below its melting point, and in which reactions may occur in the solid state.

**subspecies** (sub-spe'-cies) In the hierarchy of classification of plants and animals, a subcategory of *species*. Groups within a species that are geographically isolated from one another are geographic subspecies; groups separated in geologic time are chronologic subspecies. The name of a subspecies is a trinomen; e.g. *Bollia americana zygocornis*. Cf: *variety*.

**substage** 1. A subdivision of a stage; the rocks formed during a *subage* of geologic time. 2. A time term for a subdivision of a glacial stage during which there was a secondary fluctuation of glacial advance and retreat.

**substrate** The substance or nutrient on or in which an organism lives and grows, or the surface to

which a fixed organism is attached, e.g. soil, rock, or leaf tissue. *Syn.* *substratum*.

**substratum** (sub-strə-tum) *sub-strate*

**subsurface** (sub-sur'-face) *n.* The zone below the surface, whose geologic features, principally stratigraphic and structural, are interpreted on the basis of drill records and various kinds of geophysical evidence. *adj.* Formed or occurring beneath the earth's surface. Cf. *surficial*. See also *subterranean*.

**subsurface geology** Geology and correlation of rock formations, structures, and other features beneath the land surface as revealed or inferred by exploratory drilling, underground workings, and geophysical methods. Cf. *surface geology*.

**subsurface water** Water in the lithosphere in solid, liquid, or gaseous form. It includes all water beneath the land surface and beneath bodies of surface water. *Syn.* *subterranean water*, *underground water*, *ground water*.

**subsystem** (sub-sys'-tem) A subdivision of a geologic system. The Mississippian and Pennsylvanian may be considered subsystems of the Carboniferous System.

**subterranean** (sub-ter-ra'-ne-an) Formed or occurring beneath the earth's surface, or situated within the earth. Cf. *subaerial*. See also *subsurface*.

**succession** (suc-ces'-sion) 1. A number of rock units or a mass of strata that succeed one another in

chronologic order, e.g. a sequence shown graphically on a geologic column or seen in an exposed section. 2. The chronologic order of rock units. 3. The progressive change in a biologic community as a result of the response of the member species to the environment. See also *seres*, *faunal succession*.

**sucrose** (su'-krose) *saccharoidal*

**suevite** (sue'-vite) A grayish or yellowish breccia that is associated with meteorite impact craters and that contains both shock metamorphosed rock fragments and glassy inclusions that occur typically as aerodynamically shaped bombs. It closely resembles a tuff breccia or pumiceous tuff but is of nonvolcanic origin and can be distinguished by the presence of shock-metamorphic effects.

**sugarloaf** A conical hill or mountain comparatively bare of timber.  
**suite** 1. A collection of rock specimens from a single area, generally representing related igneous rocks. 2. A collection of rock specimens of a single kind, e.g. granites from all over the world. 3. A succession of closely associated sedimentary strata, especially a repeated sequence.

**sulcus** (sul'-cus) A surface depression in the shell of several invertebrates, e.g. a radial depression in the surface of the shell of a bivalve mollusk. Cf. *sinus*.

**sulfate** (sul'-fate) A mineral compound characterized by the sulfate radical  $\text{SO}_4$ .

**sulfide** (sul'-fide) A mineral com-

pound characterized by the linkage of sulfur with a metal, such as galena, PbS, or pyrite,  $\text{FeS}_2$ . See also *sulfosalt*

**sulfide enrichment** The enrichment of a deposit by replacement of one sulfide by another of higher value, as pyrite by chalcocite

**sulfide zone** 1 That part of a sulfide deposit that has not been oxidized by near surface waters, i.e., *oxidized zone*; *pyritite* 2 A zone in which *supergene enrichment* has occurred

**sulfosalt** (sul-fo-salt) A type of sulfide in which both a metal and a semimetal are present, forming a double sulfide, e.g., enargite,  $\text{Cu}_3\text{AsS}_4$

**sulfur** (sul-fur) An orthorhombic mineral, the native nonmetallic element S. It occurs in yellow crystals at hot springs and fumaroles, and in masses or layers associated with limestone, gypsum, and anhydrite, esp. in salt dome caprock and bedded deposits. Syn. *brimstone*. Also spelled *sulphur*

**sulfur bacteria** Anaerobic bacteria that obtain the oxygen needed in metabolism by reducing sulfate ions to hydrogen sulfide or elemental sulfur. Accumulations of sulfur formed in this way are *bacteriogenic* ore deposits. Cf. *iron bacteria*

**sulfur ball** 1 A pyritic impurity in coal occurring as a spheroidal or irregular mass 2 A sulfurous mud skin that forms on a bubble of hot volcanic gas and becomes firm on contact with the air

**summit concordance** Equal or nearly equal elevation of ridgetops or mountain summits over a region. The concordance is commonly thought to indicate the existence of an ancient erosion plain of which only scattered patches are preserved. See also *ancient summit level*

**sump** 1 An excavation for the collection of quarry or mine waters which may then be pumped out 2 A surface pit in which mined material is mixed with water to form a slurry for removal, as in certain clay districts 3 A pool of water in a cave, the outlet of which lies beneath its surface. See also *siphon*

**sun opal** *fire opal*

**sunspot** A relatively dark area on the sun's surface representing lower temperature and consisting of a dark central umbra surrounded by a penumbra which is intermediate in brightness between the umbra and the surrounding surface of the photosphere

**sunstone** A *aventurin* feldspar, usually a brilliant, translucent variety of oligoclase that emits a reddish or golden billowy reflection from minute scales or flakes of hematite spangled throughout and arranged parallel to planes of repeated twinning. Cf. *moonstone*

**supercapillary interstice** (super-cap'i-lar-y) An opening sufficiently larger than a *capillary interstice* that surface tension will not hold water far above a free water surface. Water moving in

these interstices may develop currents and eddies Cf *subcapillary interstice*.

**supercooling** The process of lowering the temperature of a phase below the point or range at which a phase change should occur at equilibrium, i.e. making the system metastable by lowering the temperature. It generally refers to a liquid taken below its liquidus temperature. Glass is an example of such a liquid Cf *superheating*. Syn *undercooling*.

**supercritical** (su-per-crit'-i-cal) Said of a system that is at a temperature higher than its critical temperature, also, said of the temperature itself.

**superficial** (su-per-fi'-cial) *superficial*

**supergene** (su'-per-gene) Said of a mineral deposit or enrichment formed near the surface, commonly by descending solutions, also, said of those solutions and of that environment Cf *hypogene*, *mesogene*. Syn *secondary*.

**supergene enrichment** The near-surface processes of mineral deposition, in which oxidation produces acidic solutions that leach metals, carry them downward, and reprecipitate them, thus enriching sulfide minerals already present. Supergene enrichment has been important in upgrading porphyry copper deposits to the status of ore. Syn *downward enrichment*, *secondary enrichment*. See also *oxidized zone*.

**supergroup** (su'-per-group) In stratigraphy, an assemblage of related

groups, or of formations and groups, having significant lithologic features in common.

**superheating** (su-per-heat'-ing) 1 The addition of more heat than necessary to complete a given phase change. 2 In a magma, the addition of more heat than is necessary to cause complete melting. The temperature increase above liquids is called the superheat. 3 The process of increasing heat beyond that point at which a phase or assemblage changes at equilibrium, i.e. to a metastable state in the sense analogous to *supercooling*.

**superimposed stream** A stream that was established on a new surface and that maintained its course despite different lithologies and structures encountered as it eroded downward into the underlying rocks. Syn *superposed stream*.

**superindividual** (su-per-in-di-vid'-u-al) An aggregate of grains that behaves as a unit in the fabric of a deformed rock, esp. mineral grains produced by granulation of a single large crystal and approximating the original orientation of the larger one.

**superjacent** (su-per-ja'-cent) Said of a stratum situated immediately upon a lower stratum or an unconformity, overlying. Ant *subjacent*.

**superposed stream** *superimposed stream*.

**superposition** (su'-per-po-si'-tion) The order in which sedimentary rocks occur in strata, one above

the other, the highest bed being the youngest. See also: *law of superposition*.

**supersaturated solution** (su-per-sat'-u-rat-ed) A solution that contains more of the solute than is normally present when equilibrium is established between the saturated solution and undissolved solute.

**superstructure** (su'-per-struc-ture) The upper structural layer in an orogenic belt, subjected to relatively shallow or near-surface deformational processes, in contrast to an underlying and more complexly deformed *infrastructure*.

**supralittoral** (su-pra-lit'-tor-al) Pertaining to the shore area marginal to the littoral zone, just above high-tide level.

**supratenuous fold** (su-pra-ten'-uous) A pattern of fold in which there is thickening at the synclinal troughs and thinning at the antichinal crests. It is formed by differential compaction on an uneven basement surface. Syn: *drape fold*.

**surf** 1. The wave activity in the surf zone. 2. A collective term for *breakers*.

**surface** (sur'-face) 1 The outside part of the solid earth or ocean, the top of the ground or the exposed part of a rock formation. 2. A two-dimensional boundary between geologic features such as formations or structures, e.g. *fault surface*, or an imaginary surface such as the *axial surface* of a fold; usually an internal

boundary, rather than one occurring on the outside of a feature. It need not be flat. Cf: *plane*.

**surface density** The density of the surface material within the range of the elevation differences of a gravitational survey. Both the Bouguer correction and the terrain correction depend on the density of the surface material.

**surface deposit** An orebody or other mineral deposit that is exposed and can be extracted in a quarry or open-cut mine.

**surface geology** 1 Geology and correlation of rock formations, structures, and other features as seen at the earth's surface. Cf *subsurface geology*. 2. *surficial geology*.

**surface of no strain** A surface along which the original configuration of an array of points remains unchanged after deformation of the body in which it occurs, e.g. a surface near the middle of a bent beam, between tension on the outer, convex side and compression on the inner, concave side. Syn: *neutral surface*.

**surface of rupture** 1 In a *slide*, the projection or extension of the major scarp surface under the disturbed material. 2 The surface of rock from which the material of a landslide or slump was removed.

**surface runoff** That part of the *runoff* that travels over the ground surface to the nearest stream without passing beneath the surface.

**surface wave** A seismic wave that

travels along the surface of the earth, or along a subsurface interface. Surface waves include the *Love wave*, *Raleigh wave*, and *coupled wave* *syn* *L wave*. See also *Lg wave*.

**surficial** (sur-fish'ial) Pertaining to or lying in or on a surface, specif. the surface of the earth, e.g. "surficial weathering" of a rock, or a "surficial structure" formed by reef. The *syn* *superficial* is more generally used in Great Britain.

**surficial geology** Geology of *surficial* deposits, including soils; the term is sometimes applied to the study of bedrock at or near the earth's surface. See also *surface geology*.

**surf zone** The area bounded by the landward limit of wave uprush and the farthest seaward *breaker*. **surge** 1 The period of very rapid flow of a *surging glacier*; also, the advance of ice resulting from this flow. 2 *storm surge*. 3 Horizontal oscillation of water with a comparatively short period, accompanying a *tide*.

**surge channel** A transverse channel cutting across the outer edge of an organic reef, in which the water level rises and falls as the result of wave and tidal action.

**surging glacier** A glacier that alternates between brief periods (usually one to four years) of very rapid flow called *surges* and longer periods (usually 10 to 100 years) of near stagnation. During a *surge*, a large volume of ice from an ice-reservoir area is displaced

downstream at speeds up to several meters per hour into an ice-receiving area, and the affected portion of the glacier is chaotically crevassed. In the interval between surges, the ice reservoir is slowly replenished, and the ice in the receiving area is greatly reduced by ablation.

**survey** 1 To delineate the extent, position, and boundaries of a tract of land, coast, harbor, or the like, esp. by means of linear and angular measurements and by applying the principles of geometry and trigonometry *n* 1 The process of finding and delineating the physical or chemical characteristics of the earth's surface, subsurface, or internal constitution by topographic, geologic, geophysical, or geochemical measurements, esp. the operation of determining the relative positions of points on, above, or beneath the earth's surface. 2 The results obtained in a survey; a map or description of an area obtained by surveying. 3 An organization engaged in making surveys, e.g. a government agency such as the U.S. Geological Survey.

**surveying** The act of making a survey; specif. making such measurements as are necessary to determine the area of any part of the earth's surface, the lengths and directions of the boundary lines, and the contour of the surface, and of accurately delineating the whole on paper.

**survival of the fittest** (sur-viv'-al)



The tendency for the environmentally better-adapted members of a population to survive to reproductive age and thus to contribute more strongly to the genetic composition of the next generation than the poorly adapted members do.

**susceptibility** (sus-cep-ti-bil-i-ty) *magnetic susceptibility.*

**suspended load** The part of the total stream load that is carried for a considerable period of time in suspension, free from contact with the stream bed; it consists mainly of clay, silt, and sand. Syn. *suspension load; wash load.*

**suspended water** *vadose water*

**suspension** (sus-pen-sion) 1. A mode of sediment transport in which the upward currents in eddies of turbulent flow are capable of supporting the weight of sediment particles and keeping them indefinitely held in the surrounding fluid (such as silt in water or dust in air). Cf. *salination; traction*. 2. The state of a substance in such a mode of transport; also, the substance itself.

**suspension current** *turbidity current.*

**suspension load** *suspended load.*

**suture** (su'-ture) A boundary line or line of contact, e.g. the line of junction of a septum of a cephalopod's shell with the inner surface of the shell wall, or between two chambers or two whorls of a foraminiferal test.

**swale** 1. A slight depression, sometimes swampy, in the midst of generally level land. 2. A shallow

depression in an undulating ground moraine due to uneven glacial deposition. 3. A long, narrow, generally shallow depression between two *beach ridges*.

**swallow hole** A closed depression or sinkhole into which all or part of a stream disappears underground.

**swamp** An area intermittently or permanently covered with water, having shrubs and trees but essentially without the accumulation of peat. Cf. *marsh, bog.*

**swamp theory** *in-situ theory.*

**swash** The rush of water up onto the beach following the breaking of a wave, *uprush*.

**swash mark** A thin delicate wave or arcuate line or very small ridge on a beach, marking the farthest advance of wave uprush. It is convex landward and consists of fine sand, mica flakes, bits of seaweed, and other debris. Syn. *wavemark, debris line.*

**S wave** A seismic wave propagated by a shearing motion that involves oscillation perpendicular to the direction of propagation. It does not travel through liquids, or through the outer core of the earth. Its speed is 3.0-4.0 km/sec in the crust and 4.4-4.6 km/sec in the upper mantle. The *S* stands for secondary, it is so named because it arrives later than the *P* wave (primary wave). Syn. *shear wave; secondary wave; rotational wave; tangential wave; distortional wave; transverse wave.* Cf. *P wave.*

**sweet** Said of crude oil or natural

gas that contains few or no sulfur compounds Cf *sour*.

**swell** 1 The increase in volume exhibited by certain soils and rocks on absorption of water 2 An oceanic rise 3 An enlarged place in an orebody, as opposed to a *pinch* 4 A general, imprecise term for *dome* and *arch* 5 One of a series of regular, long-period ocean waves that has traveled out of its generating area

**swell-and-swale topography** Topography of ground moraine having low relief and gentle slopes

**syenite** (sy'-e-nite) A group of plutonic rocks usually containing orthoclase, microcline, or perthite, a small amount of plagioclase, one or more mafic minerals (esp. hornblende), and little or no quartz, also, any rock in that group Syenite is the intrusive equivalent of *rachyte* With an increase in the quartz content, it grades into *granite* Its name is derived from Syene (now Aswan), Egypt

**syenodiorite** (sy'-e-no-di'-o-nite) *monzonite*

**syenogabbro** (sy'-e-no-gab'-bro) A plutonic rock differing in composition from *gabbro* by the presence of alkali feldspar

**sylvinite** (syl'-vin-ite) A mixture of halite and sylvite, mined as a potash ore, a rock that contains chiefly impure potassium chloride

**sylvite** (syl'-vite) A white or colorless isometric mineral KCl It is the principal ore mineral of potas-

sium compounds Sylvite occurs in beds as a saline residue with halite and other evaporites It has a sharper taste than that of halite  
**symbiosis** (sym-bi-o'-sis) The relationship that exists between two different organisms that live in close association, with at least one being helped without either being harmed Cf *mutualism*, *commensalism*, *parasitism* Adj *symbiotic*

**symbol** A design or other graphic device placed on maps and diagrams, which by convention or reference to a legend is understood to represent a specific feature, such as a rock outcrop or a mine opening

**symmetrical bedding** (sym-met'-ri-cal) Stratification characterized by lithologic types or facies that follow each other in a "retracing" arrangement illustrated by the sequence 1-2 3-2 1-2 3-2 1 etc

**symmetrical fold** A fold whose limbs have the same angle of dip relative to the axial surface Cf *asymmetrical fold*

**symmetry** (sym'-me-try) 1 The repeat pattern of similar crystal faces that indicates the ordered internal arrangement of a crystalline substance 2 In organisms, *bilateral symmetry* or *radial symmetry* 3 In structural petrology, the combined symmetry of all the elements making up a fabric

**symmetry axis** *axis of symmetry*

**symmetry elements** The axes, plane, and center of symmetry, by which crystal symmetry can be

described There are 32 possible arrangements of the elements of symmetry each arrangement is a crystal class

**symmetry plane** *plane of symmetry*

**synaeresis** (syn-ae'-e-sis) *synaeresis*

**syntectic** (syn-an-tec'-tic) Said of a primary igneous mineral formed by the reaction of two other minerals, as in the formation of a reaction rim

**synchronous** (syn'-chro-nal) *synchronous*

**synchronous** (syn'-chro-nous) Occurring or formed at the same time Contemporary or simultaneous The term is applied to rock surfaces on which every point has the same geologic age, to growth (or depositional) faults, and to plutons emplaced contemporaneously with orogenies Cf *isochronous* *diachronous* Syn *synclinal*

**synclinal** (syn-cl'-nal) Pertaining to a syncline

**synclinal axis** The line which, moved parallel to itself, generates the form of a syncline

**synclinal mountain** A mountain whose underlying structure is that of a syncline

**syncline** (syn'-cline) A fold of which the core contains the stratigraphically younger rocks, it is generally concave upward Ant *anticline* See also *synform* Adj *synclinal*

**synclinorium** (syn-cl'-no'-ri-um) A composite synclinal structure of regional extent composed of less-

er folds Cf *anticlinorium* See also *geosyncline* Pl *synclinoria*  
**synecolology** (syn-e-col'-o-gy) The study of the relationships between communities and their environments Cf *autecology*

**syneresis** (syn-er'-e-sis) The spontaneous throwing-off of a liquid by a gel during aging, resulting in shrinkage and in the formation of cracks Also spelled *synaeresis*  
**synform** A fold whose limbs close downward in strata for which the stratigraphic sequence is unknown Cf *syncline* Ant *antiform*

**syngensis** (syn-gen'-e-sis) The formation of unconsolidated sediments in place early *diagenesis*  
**syngenetic** (syn-ge-net'-ic) 1 Said of a mineral deposit formed at the same time, and by the same processes as the enclosing rocks 2 Said of a primary structure, such as a ripple mark, formed contemporaneously with the deposition of the sediment in which it occurs —Cf *epigenetic*

**synonym** (syn'-o-nym) One of two or more names applied to the same taxon See also *synonymy*

**synonymy** (syn-on-y-my) 1 The relationship between two or more different names that have been applied to the same taxon 2 A list of synonyms that have been applied to a particular taxon

**synorogenic** (syn-o-ro-gen'-ic) Said of a geologic process or event occurring during a period of orogenic activity, or said of a rock or feature so formed Cf *syntectonic*

**synsedimentary** (syn-sed-i-men'-ta-ry) Accompanying deposition, specif. said of a sedimentary ore deposit in which the ore minerals formed contemporaneously with the enclosing rock

**syntaxial** (syn-tax'-i-al) Adj. of *synclinal*

**syntaxis** (syn-tax'-is) A sharp bend in an orogenic belt accompanied by a separation into several ranges Cf. *virgation*

**syntaxy** (syn-tax'-y) Similar crystallographic orientation in a mineral grain and its overgrowth Adj. *syntaxial*

**syntectic** (syn-tek'-tik) The adj. of *syntexis*

**syntectite** (syn-tek'-tite) A rock formed by syntexis See also *anorthite*

**syntectonic** (syn-tek-ton-ik) Said of a geologic process or event occurring during any kind of tectonic activity or of a rock or feature so formed Cf. *synorogenic*

**syntexis** (syn-tek'-is) The formation of magma by melting of two or more rock types and assimilation of country rocks and/or anatexis of two or more rock types Adj. *syntectic*

**synthetic fault** (syn-thet-ik) A non-normal fault that has been simulated as the type of fault with which it is associated

Cf. *antithetic fault*

**synthetic group** A rock-stratigraphic unit consisting of two or more formations that are associated because of similarities or close relationships between their fossils or lithologic characters Cf. *analytic group*

**syntype** Any of the specimens on which the description of a species or subspecies is based when a *holotype* has been designated

**system** 1. A major chronostratigraphic unit of worldwide significance the fundamental unit of chronostratigraphic classification extended from a type area to a region and correlated mainly by its fossil content the rock formed during a period of geologic time It is of the rank above *series* and below *era* *form* 2. A group of related natural features *rock drainage system* or *mountain system* 3. *crystal system* 4. A conceptual range of compositions defined by a set of components in terms of which all compositions in the system can be expressed e.g. the system  $\text{CaO}-\text{MgO}-\text{SiO}_2$

**systematics** (sys-tem-at-iks) The study of the types and diversity of organisms and their relationships Cf. *taxonomy* *classification*

## T

**tableland** 1 A general term for a broad, elevated region with a nearly level or undulating surface of considerable extent, e.g. South Africa. 2 A *plateau* bordered by abrupt clifflike edges rising sharply from the surrounding lowland, as *mesa*.

**tablemount guyot**

**tabular** (tab'-u-lar) 1 Said of a feature having two dimensions that are much larger or longer than the third, such as an igneous dike, or of a geomorphic feature having a flat surface, such as a plateau. 2 Said of the shape of a sedimentary body whose width/thickness ratio is greater than 50 to 1, but less than 1000 to 1. Cf. *blanket deposit*. 3 Said of a sedimentary particle or a crystal form that shows one dimension markedly smaller than the other two. Cf. *prismatic*. 4 Said of a metamorphic texture in which a large proportion of grains are tabular and have approximately parallel orientation.

**tachygenesis** (ta-chy-gen'-e-sis)

The extreme crowding and eventual loss of those primitive phylogenetic stages that are represented early in the life of an individual. Cf. *acceleration*.

**tachylite** (ta'-chy-lyte) A volcanic glass of basaltic composition. Syn. *sideromelane*. See also *pseudotachylite*.

**tachymeter** (ta-chym'-e-ter) A surveying instrument designed for

use in rapid determination of distance, direction, and difference of elevation from a single observation, using a short base, which may be an integral part of the instrument. *Range finders* with self-contained bases belong to this class.

**Taconic orogeny** (Ta-con'-ic) An orogeny in the latter part of the Ordovician period, named for the Taconic Range of eastern New York State, well developed through most of the northern Appalachians in the U.S. and Canada. In places it can be strictly defined as Late Ordovician by limiting fossiliferous strata, but elsewhere it can be extended to include many pulsations that occurred from place to place from early in the Ordovician to early in the Silurian.

**tacouite** (tac'-o-nite) 1 A local term used in the Lake Superior iron-bearing district of Minnesota for any bedded ferruginous chert or jaspery rock, esp. one that enclosed the Mesabi iron ores (granular hematite); an unleached iron formation. 2 Since World War II, a low-grade iron formation suitable for concentration of magnetite and hematite by fine grinding and magnetic treatment, from which pellets containing 62 to 65% iron can be produced.

**tactite** (tac'-tite) A rock of complex mineralogical composition, formed by contact metamorphism and metasomatism of carbonate rocks. It is typically coarse-grained and rich in garnet,

iron-rich pyroxene, epidote, wolastonite, and scapolite. Approx. syn *skarn*.

**tailings** Those portions of washed or milled ore that are regarded as too poor to be treated further, as distinguished from the *concentrates* or material of value.

**talc** 1. An extremely soft light green or gray monoclinic mineral,  $Mg_3Si_4(OH)_2$ . It has a characteristic soapy feel and a hardness of 1 on the Mohs scale and it is easily cut with a knife. Talc is a common secondary mineral derived by hydration of magnesium silicates (such as olivine, enstatite, and tremolite) in basic igneous rocks or by metamorphism of dolomite rocks, and it usually occurs in foliated, granular or fibrous masses. See also *serpentine*. 2. In commercial usage, a talcose rock, a rock consisting of talc, tremolite, chlorite, anthophyllite, and related minerals. It is used as a filler, coating, and dusting agent in ceramics, rubber, plastics, and lubricants.

**talus** 1. Rock fragments, usually coarse and angular, lying at the base of a cliff or steep slope from which they have been derived; also, the heap or mass of such broken rock, considered as a unit. Syn. *scree*. 2. *reef talus*.

**talus creep** The slow downslope movement of talus, either in individual rock fragments or the mass as a whole.

**tangential cross-bedding** (tan-jen-tial) Cross-bedding in which the foreset beds appear in section as

smooth arcs meeting the underlying surface at low angles; large-scale tangential cross-bedding is commonly believed to imply deposition by wind. Cf. *angular cross-bedding*.

**tangential stress** *shear stress*.

**tangential wave** *S wave*.

**tank** 1. A term applied in southwestern U.S. to a natural depression in impervious rocks in which water is collected and preserved during the greater part of the year. 2. A natural or artificial reservoir for supplying water for livestock.

**tantalite** (tan-'ta-lite) A black mineral  $(Fe, Mn)(Ta, Nb)_2O_6$ . It is isomorphous with *columbite*, occurs in pegmatites, and is the principal ore of tantalum.

**taphrogenesis** (taph-ro-jen-e-sis) *taphrogeny*.

**taphrogeny** (taph-roj'-e-ni) A general term for the formation of rift phenomena, characterized by high angle normal faulting and associated subsidence. Etymol. Greek, *taphros* "trench." Adj. *taphrogenic*. Syn. *taphrogenous*.

**taphrogenosyncline** (taph-ro-je-n-syn-cline) A sediment-filled, deeply depressed crustal block bounded by faults.

**tarn** *cirque lake*.

**tarnish** (tar-'nish) A thin film that forms on the surface of certain minerals, esp. those containing copper. Its color and luster are different from those of the fresh mineral.

**tar pit** An area in which an accumulation of natural bitumen is

exposed at the land surface, forming a trap into which animals (esp. vertebrates) fall and sink their hard parts being preserved in the bitumen. Example: La Brea tar pits, Los Angeles, Calif.

**tar sand** A sand body that is large enough to hold a commercial reserve of asphalt; it may be an oil sand from which the lighter volatiles have escaped.

**tasmanite** (tas'ma-nite) An impure coal transitional between cannel coal and oil shale.

**tautonym** (tau'to-nym) The name of a species in which the term designating the genus is the same as that for the species, e.g. *Trogodytes troglodytes*.

**taxa** The plural of *taxon*.

**taxon** A named group of organisms of any rank, such as a particular species, family, or class; also the name applied to that unit. A taxon may be designated by a formal Latin name or by a letter number or other symbol. Plural: *taxa*, *taxons*.

**taxonomy** (tax-on'-o-my) The theory and practice of classifying plants and animals. The terms *taxonomy* and *systematics* are usually distinguished, the latter having broader connotation but they may also be used more or less synonymously. Cf. *classification*.

**T-chert** Tectonically controlled chert occurring in irregular masses related to fractures and ore bodies. Cf. *W-chert*.

**T D** 1. *time depth*. 2. *time distance*.

**T D curve** *time distance curve*.

***t* direction** A term used in crystal plasticity to denote the direction of slip in a crystallographic slip plane. See also *f axis*, *T plane*.

**T-dolostone** Tectonically controlled dolostone, occurring in irregular masses related to fracture systems. Cf. *S-dolostone*, *W-dolostone*.

**TAT analysis** A method of measuring the velocity of seismic waves from normal moveout and arrival time measurements.

**tear fault** A steep to vertical fault in the hanging wall of a low-angle overthrust fault. Its strike is perpendicular to that of the overthrust. Displacement is commonly horizontal and tear faults are considered by some to be a type of strike-slip fault.

**tectofacies** (tec-to-la'-cies) A group of strata of different tectonic aspect from laterally equivalent strata. The term is of limited practical value. Not to be confused with *tectonic facies*.

**tectogene** (tec'-to-gene) A long, narrow unit of downfolding of silicic crust considered to be related to mountain building processes. Cf. *downbuckle*.

**tectogenesis** (tec-to-gen'-e-sis) *orogony*.

**tectonic** (tec-ton-ic) Pertaining to the forces involved in, or the resulting structures of, *tectonics*. Syn. *geotectonic*.

**tectonic axis** *fabric axis*.

**tectonic breccia** An aggregation of angular rock fragments formed as the result of tectonic movement, a *crush breccia*.

**tectonic conglomerate** *crush or glomerate*

**tectonic cycle** *orogenic cycle*

**tectonic fabric** *deformation fabric*

**tectonic facies** A collective term for rocks that owe their present characteristics mainly to tectonic activity, e.g. mylonites and some phyllites. Not to be confused with *tectofacies*.

**tectonic framework** The structural elements of a region including the rising stable and subsiding areas, **tectonic land**, linear fold ridges and volcanic islands that had a temporary existence in the internal parts of an orogenic belt during the early or geosynclinal phase. They have been compared with modern island arcs; their existence may account for many of the features formerly ascribed to *borderlands*.

**tectonic map** A map that portrays the geological architecture of a region. It shows dipping strata, folds, faults and the like, but it also presents some indication of the ages and kinds of rocks from which the structures were made, as well as some indication of their historical development. Cf. *paleotectonic map*.

**tectonics** A branch of geology dealing with the broad architecture of the outer part of the earth, that is, the major structural or deformational features and their relations, origin and historical evolution. It is closely related to *structural geology*, but tectonics generally deals with larger features. Adj. *tectonic*.

**tectonic style** The total character of a group of related structures that distinguishes them from other groups of structures in the same way that the style of a building or of an object distinguishes it from others of different periods or influences.

**tectonism** (*tec-ton-iz-um*) *diastrophism*

**teconite** (*tec-ton-ite*) Any rock whose fabric reflects the history of its deformation, a rock whose form clearly displays coordinated geometric features that indicate continuous solid flow during formation.

**tectonophysics** (*tec-ton-o-fiz-iks*) A branch of geophysics that deals with the forces responsible for movement in and deformation of the earth's crust.

**tectonosphere** (*tec-ton-o-sph-er*) The zone or layer of the earth above the level of isostatic equilibrium in which crustal or tectonic movements originate.

**tectosilicate** (*tec-to-sil-i-cate*) A class or structural type of *silicate* characterized by the sharing of all four oxygens of the  $\text{SiO}_4$  tetrahedra with neighboring tetrahedra and with a  $\text{SiO}_2$  ratio of  $\geq 2$ . Quartz ( $\text{SiO}_2$ ) is an example.

**tectosome** (*tec-to-some*) A body of strata indicative of uniform tectonic conditions, the sedimentary rock record of a tectonic environment or *tectotope*.

**tectotope** (*tec'-to-tope*) An area of uniform tectonic environment, recognition of which depends on interpretation of a *tectosome*. The



term is of doubtful value.

**teichron** *teizone*

**teizone** 1 A time term originally introduced to designate the local duration of existence of a species. *Syn.* *teichron*. 2 A syn of local *range-zone*. *Etymol.* German *Teizone* "part zone"

**tektite** (tek'-tite) A rounded pitted jet-black to greenish or yellowish body of silicate glass of nonvolcanic origin, usually walnut-sized, found in groups in several widely separated areas of the earth's surface. Most tektites are high in silica (68-82%) and very low in water content (average 0.005%); their composition is unlike that of obsidian and more like that of shale. Tektites average a few grams in weight. They are believed to be of extraterrestrial origin or alternatively the product of large hypervelocity meteorite impacts on terrestrial rocks. *Etymol.* Greek *tektaos*, "molten"

**telemagmatic** (tel'-e mag-mat'-ic) Said of a hydrothermal mineral deposit located far from its magmatic source

**teletothermal** (tel'-e-ther'-mal) Said of a hydrothermal mineral deposit formed at shallow depth and relatively low temperatures, with little or no wall-rock alteration, presumably far from the source of hydrothermal solutions. Also, said of that environment. See also *telemagmatic*. Cf. *hypothermal*, *mesothermal*, *epithermal*

**telluride** (tel'-lu'-ride) Pertaining to the earth, esp. the depths of the earth, e.g. as applied to natural

electric fields or currents

**telluric current** *earth current*

**telluride** (tel'-lu'-ride) A mineral compound that is a combination of tellurium with a metal. An example is hessite,  $\text{Ag}_2\text{Te}$

**TEM** *transmission electron microscope*

**temblor** (tem blor') A syn. of *earthquake*. *Etymol.* Spanish, a "trembling"

**temperate glacier** (tem'-per-ate) A glacier characteristic of the temperate zone, in which at the end of the ablation season the firm and ice of which it consists are near the melting point. Examples almost all the glaciers in Scandinavia and the Alps, and in the U.S. outside of northern Alaska. Cf. *polar glacier*. *Syn.* *warm glacier*

**temperature gradient** (tem'-per-ature) *thermal gradient*

**temporary base level** (tem'-po-rar-y) Any base level, other than sea level, below which a land area cannot be reduced, for the time being, by erosion, e.g. a level locally controlled by a resistant stratum in a stream bed or by the surface of a lake. Cf. *ultimate base level*

**tennantite** (ten'-nant'-ite) A blackish lead-gray isometric mineral,  $(\text{Cu}, \text{Fe})_{10}\text{As}_4\text{S}_{11}$ . It is isomorphous with tetrahedrite, and sometimes contains zinc, silver, or cobalt replacing part of the copper. It is an important ore of copper.

**tenor** (ten'-or) The grade of an orebody

**tensile strength** (ten'-sile) The ability of a material to resist a stress tending to stretch it or to pull it apart

**tensile stress** A *normal stress* that tends to pull apart the material on the opposite sides of the plane on which it acts Cf *compressive stress*

**tension** (ten'-sion) Stress that tends to pull a body apart

**tension fault** A genetic term for any fault caused by tension

**tension fracture** A fracture in rock that is the result of stresses that tend to pull the rock apart Cf *shear fracture*

**tension joint** A joint that is a *tension fracture*

**tepee butte** (te'-pee) A conical erosion hill, so named from its resemblance to the Indian wigwam or tepee Cf *klint*

**tepee structure** A sedimentary structure which in cross section resembles a chevron or Indian tepee. It is believed to be an early diagenetic structure formed at the margins of large polygons produced by expansion of surface sediments

**tephra** (teph'-ra [tef'-ra]) A collective term for all elastic material ejected from a volcano and transported through the air. It includes volcanic dust, ash, cinders, lapilli, scoria, pumice, bombs, and blocks. Syn. *volcanic ejecta*

**tephrochronology** (teph-ro-chro-nol-o-gy) The correlation, description, and approximate dating of *tephra*

**terminal moraine** (ter-mi-nal) The

outermost *end moraine* of a glacier or ice sheet, marking the maximum advance of the ice

**terminus** (ter'-mi-nus) The outer margin or extremity of a glacier

**ternary system** A system of three components, e.g.  $\text{CaO-Al}_2\text{O}_3\text{-SiO}_2$

**terra** (ter'-ra) An upland or mountainous region on the surface of the moon, characterized by a lighter color than that of a *mare* by relatively high albedo, and by a rough texture formed by large overlapping craters. It may be a remnant of an ancient lunar surface, sculptured\* by impact of meteorites, or it may be a result of volcanic activity from within the moon. Etymol. Latin, "earth" Pl. *terrae*

**terrace** 1 A relatively level bench or steplike surface breaking the continuity of a slope. The term is applied to both the lower or front slope (the riser) and the flat surface (the tread). 2 *stream terrace* 3 *marine terrace* 4 *structural terrace* 5 A horizontal embankment along the contour of a hill side, built to conserve moisture or reduce erosion

**terraced pool** (ter'-raced) One of the shallow, rimmed pools on a reef surface, produced by the growth of lime and silica-secreting algae and arranged in successively lower terraces

**terra-cotta** A fired or kiln burnt clay of a peculiar brownish-red or yellowish red color, used for statuettes, figures, and vases, and for ornamental work on the ex-

tenor of buildings. Also, an object made of terra-cotta. Etymol Italian, "baked earth"

**terra-cotta clay** A term applied loosely to any fine-textured, fairly plastic clay that acquires a natural vitreous skin in burning and that is used in the manufacture of terra-cotta. It is characterized by low shrinkage, freedom from warping, strong bonding, and absence of soluble salts

**terrain** (ter-rain') 1 A tract or region of the earth's surface considered as a physical feature, an ecologic environment or a site of some planned activity of man, e.g. an engineering location, or in terms of military science, as in *terrain analysis*. 2 An obsolete syn of *terrane*

**terrain analysis** The process of interpreting a geographical area to determine the effect of the natural and man-made features on military operations

**terrain correction** A correction applied to observed values obtained in geophysical surveys in order to remove the effect of variations due to the topography. Syn *topographic correction*.

**terrane** An obsolescent term applied to a rock or group of rocks and to the area in which they crop out. The term is used in a general sense and does not imply a special rock unit. Obsolete syn *terrain*.

**terra rossa** Residual red clay mantling limestone bedrock. Etymol Italian, "red earth"

**terrestrial** (ter-rē-strī-al) 1 Per-

taining to the earth. 2 Pertaining to the earth's dry land. Cf. *continental*.

**terrestrial deposit** 1 *continental deposit*. 2 Strictly, a sedimentary deposit formed on land without the action of water, e.g. glacial till or sand dunes

**terrestrial magnetism** *geomagnetism*

**terrigenous** (ter-rig'-e-nous) Derived from the land or a continent

**terrigenous deposit** Shallow marine sediment consisting of material eroded from the land surface. Cf. *hemipelagic deposit*, *pelagic deposit*

**Tertiary** (Ter'-ti-ary) The first period of the Cenozoic era (after the Cretaceous of the Mesozoic era and before the Quaternary), thought to have covered the span of time between 65 million and 2 million years ago; also, the corresponding system of rocks. It is divided into five epochs: the Paleocene, Eocene, Oligocene, Miocene, and Pliocene. It was originally designated an era rather than a period; in this sense, it may be considered to have either five periods (Paleocene, Eocene, Oligocene, Miocene, Pliocene) or two (Paleogene and Neogene), with the Pleistocene and Holocene included in the Neogene

**test** 1 The shell or supporting skeleton of many invertebrates, e.g. of an echinoid or a foraminifer. 2 A *drill stem test* or other procedure for sampling the content of an oil or gas reservoir. 3

**test well.**

**test well 1.** A well drilled to determine the presence and commercial value of oil or gas in an unproven area. Syn: *test*. 2. A well dug or drilled in search of water, for example, near a lake to determine the relation between lake level and ground-water level.

**tetartohedral** (te-tar'-to-he'-dral) Said of that crystal class in a system, the general form of which has only one fourth the number of equivalent faces of the corresponding form in the *holohedral* class of the same system. Cf. *merohedral*.

**Tethys** (Te'-thys) An ocean that occupied the general position of the Alpine-Himalayan orogenic belt between the Hercynian and Alpine orogenies. It was largely obliterated by the Alpine-Himalayan continental collision.

**tetrasoral** (tet-ra-cor'-al) A coral with fourfold symmetry.

**tetragonal system** (te-trag'-o-nal) One of the six *crystal systems*, characterized by three mutually perpendicular axes, the vertical one of which is a fourfold rotation or symmetry axis, it is longer or shorter than the two horizontal axes, which are of equal length.

**tetrahedral coordination** (tet-ra-he'-dral) An atomic arrangement in which an ion is surrounded by four ions of opposite sign, whose centers form the points of a tetrahedron around it. It is typified by  $\text{SiO}_4$ .

**tetrahedral radius** The radius of a cation when in tetrahedral coordi-

nation.

**tetrahedrite** (tet-ra-he'-drite) A metallic isometric mineral,  $(\text{Cu}, \text{Fe})_{12}\text{Sb}_4\text{S}_{13}$ . It is isomorphous with tennantite, and often contains silver or other metals replacing part of the copper. Tetrahedrite is an important ore of copper and sometimes an ore of silver.

**tetrahedron** (tet-ra-he'-dron) A crystal form in the isometric system, having four faces each with equal intercepts on all three axes.

**tetrahexahedron** (tet'-ra-hex'-a-he'-dron) An isometric crystal form with 24 faces, each parallel to one crystallographic axis and cutting the others at unequal distances. The faces are isosceles triangles arranged four to each side of a cube.

**tetrapod** (tet'-ra-pod) n. An animal with four limbs; an informal term to distinguish amphibians, reptiles, and mammals from aquatic classes in which paired limbs are absent or are fins instead of legs.—adj. Four-legged.

**textural maturity** (tex'-tur-al) A type of sedimentary maturity in which a sand approaches the textural end product to which it is driven by the formative processes that operate upon it. It is defined in terms of uniformity of particle size and perfection of rounding, and is independent of mineral composition.

**texture** (tex'-ture) 1. The general appearance or character of a rock, including the geometric aspects of, and mutual relations among, its component particles or crys-

als, e.g. the size, shape, and arrangement of the constituent elements of a sedimentary rock. The term is applied to the smaller features, as seen on a smooth surface of a rock, the term *structure* is generally used for the larger features. 2 The physical nature of a soil according to the relative proportions of sand, silt, and clay. 3 *topographic texture*.

**thallophyte** (thal'-lo-phyte) A non-vascular plant without differentiated roots, stems, leaves, flowers, or seeds. Algae and fungi are thallophytes. Cf. *bryophyte*, *pteridophyte*.

**thalweg** (thal weg [tal' veg]) 1 The line connecting the lowest points along a stream bed or valley, a *longitudinal profile*. 2 The line of continuous maximum descent from any point on a land surface, e.g. the line crossing all contour lines at right angles. 3 A ground-water stream percolating beneath and in the same direction as a surface stream. 4 The deepest or best navigable channel used in defining water boundaries between states. Etymol. German "valley way".

**thanatocoenosis** (than a-t-see-no'-sis) A set of fossils brought together after death by sedimentary processes rather than by virtue of having originally lived there collectively. Cf. *biocoenosis*. Syn. *death assemblage*. Plural *thanatocoenoses*. Etymol. Greek *thanatos*, 'death' + *koinos*, 'general, common'.

**thaw lake** 1 A lake or pond in a

permafrost area, in a basin formed by thawing of ground ice. 2 A pool of water on the surface of a large glacier, formed by accumulation of meltwater.

**theca** (the'-ca) The skeletal covering or wall of various invertebrates, e.g. the dorsal cup of the calyx of a crinoid, or a tube that housed an individual of a graptolite colony. Adj. *thecal*.

**theodolite** (the-od'-o-lite) A precision surveying instrument for measuring horizontal and vertical angles. See also *transit*.

**theory** (the'-o-ry) A concept or proposition, developed from a hypothesis, that is supported by experimental or factual evidence but is not so conclusively proved as to be acceptable as a law, e.g. the theory of plate tectonics.

**thermal** (ther'-mal) adj. Pertaining to or caused by heat.—n. 1 An interglacial interval. 2 A vertically moving current of air that is caused to rise by differential heating of the ground below it.

**thermal analysis** The study of chemical and/or physical changes in materials as a function of temperature, i.e. the heat evolved or absorbed during such changes. See also *differential thermal analysis*.

**thermal conductivity** 1 The time rate of transfer of heat by conduction, through unit thickness, across unit area for unit difference of temperature. 2 A measure of the ability of a material to conduct heat. Typical values of thermal conductivity for rocks range

from 3 to 15 millicalories/cm-sec-°C.—Syn *heat conductivity*.

**thermal diffusivity** *Thermal conductivity* of a substance divided by the product of its density and specific heat capacity. In rock, the common range of values is from 0.005 to 0.025 cm<sup>2</sup>/sec.

**thermal gradient** The rate of change of temperature with distance. When applied to the earth, the term *geothermal gradient* may be used. Syn *temperature gradient*.

**thermal metamorphism** A type of metamorphism resulting in chemical reconstitution controlled by a temperature increase, and influenced to a lesser extent by confining pressure, there is no requirement of simultaneous deformation.

**thermal resistivity** The reciprocal of thermal conductivity.

**thermal stratification** The stratification of a lake produced by changes in temperature at different depths and resulting in horizontal layers of differing densities. See also *density stratification*.

**thermal structure** An arrangement of zones of increasing metamorphic grade in some distinct structural pattern, for example, a thermal anticline or a thermal dome. Such features are associated with orogenesis and are produced by a localized heat source, possibly accompanied by anatexis.

**thermocline** (ther'-mo-cline) 1 The plane in a thermally stratified lake located at the depth where

temperature decreases most rapidly with depth. See also *metalimnion*. 2 A vertical, negative gradient of temperature that is characteristic of the layer of ocean water under the *mixed layer*, also, the layer in which this gradient occurs. Cf *pycnocline*.

**thermodynamic process** (ther'-mo-dy-nam'-ic) A change in any macroscopic property of a thermodynamic system.

**thermodynamics** The mathematical treatment of the relation of heat to mechanical and other forms of energy.

**thermohaline** (ther-mo-hal'-ine) Said of vertical movements of seawater, generated by density differences, they are caused by variations in temperature and salinity, which induce convection and mixing.

**thermokarst** (ther-mo-karst') A region marked by *thermokarst topography*.

**thermokarst topography** An irregular land surface containing cave-in lakes, bogs, caverns, pits, and other small depressions, formed in a permafrost region by the melting of ground ice; in exterior appearance, it resembles the uneven *karst topography* formed by the solution of limestone.

**thermoluminescence** (ther'-mo-lu-mi-nes'-cence) The property possessed by many minerals of emitting light when heated. It is from release of energy stored as electron displacements in the crystal lattice.

**thick bands** A field term that, in

accordance with a scale established for use in describing banded coal, denotes vitrain bands with a range of thickness from 5.0 to 50.0 mm Cf *thin bands, medium bands, very thick bands.*

**thick-bedded** A relative term applied to sedimentary beds with a thickness in the range of 60-120 cm (2-4 ft), a bed greater than 120 cm being "very thick-bedded" Cf *thin-bedded* See also *stratification index*

**thin bands** A field term that, in accordance with a scale established for use in describing banded coal, denotes vitrain bands with a range of thickness from 0.5 to 2.0 mm Cf *medium bands, thick bands, very thick bands*

**thin-bedded** A relative term applied to sedimentary beds with a thickness in the range of 5-60 cm (2 in. to 2 ft), a bed less than 5 cm but more than 1 cm thick being "very thin-bedded" Cf *thick-bedded* See also *stratification index*

**thiolite** (thin'-o-lite) 1 A pale-yellow to light-brown variety of calcite, often terminated at both ends by pyramids 2 A *tufa* deposit, consisting in part of layers of delicate prismatic skeletal crystals of the mineral thiolite up to 20 cm long and 1 cm thick, it occurs in domelike masses along the shores of extinct Lake Lahontan, northwest Nevada

**thin out** To grow progressively thinner in one direction until extinction The term is applied to a stratum, vein, or other body of

rock that decreases gradually in thickness so that its upper and lower surfaces eventually meet and the layer of rock disappears The thinning may be original or due to truncation beneath an unconformity Syn *pinch out, wedge out*

**thin section** A fragment of rock or mineral mechanically ground to a thickness of approximately 0.03 mm, and mounted between glasses as a microscope slide This reduction renders most rocks and minerals transparent or translucent, thus making it possible to study their optical properties Syn *section*

**thin-skinned structure** A concept that folds and faults of miogeosynclinal and foreland rocks in an orogenic belt involve only the upper strata, and lie on a *décollement* beneath which the structure differs, it is also called the "no-basement" concept Proposed examples are in the Valley and Ridge and Plateau provinces of the Appalachian belt, and in the Jura Mountains

**thixotropy** (thix-ot'-ro-py) The property of certain colloidal substances, e.g. a bentonitic clay, to weaken or change from a gel to a sol when disturbed but to increase in strength upon standing

**tholeiite** (tho'-lei-ite) A *basalt* characterized by the presence of orthopyroxene and/or pigeonite in addition to clinopyroxene and calcic plagioclase Olivine may be present The term is derived from Tholey, Saarland, Germany

**thorax** (tho'-rax) The central part of the arthropod body, consisting of several segments that generally are movable

**three-layer structure** A type of crystal structure having three unit layers to the full repeat unit; e.g. some phlogopites, which have one octahedral and two tetrahedral layers per unit along the *c* axis. Such micas are usually hexagonal. Cf. *two-layer structure*.

**three-point method** 1. The geometric determination of dip and strike of a structural surface whose elevation is known at three accurately located points. 2. The determination of geographic position inside or outside the triangle formed by the intersection of bearing lines from three triangulation stations.

**threshold** (thresh'-old) 1. A submarine ridge near the mouth of a fiord, see *sill*. 2. A low, transverse ridge of bedrock on the floor of a glacial valley, separating a rock basin from the gently sloping valley bottom farther downstream. 3. In geochemistry, the lowest detectable value, the point at which a process or effect commences

**threshold pressure** *yield stress*.

**threshold velocity** The minimum velocity at which wind or water, in a given place and under specified conditions, will begin to move particles of soil, sand, or other material

**through glacier** A double-ended glacier, consisting of two valley glaciers situated in a single depression, from which they flow

in opposite directions. A "through-glacier system" is a body of glacier ice consisting of interconnected through glaciers that may lie in two or more drainage systems. Cf. *transection glacier*.

**throw** 1. On a fault, the amount of vertical displacement. Cf. *heave*. See also: *upthrow*, *downtthrow*. The vertical component of the net slip

**thrust** *thrust fault*.

**thrust fault** A fault with a dip of 45° or less over much of its extent on which the hanging wall appears to have moved upward relative to the footwall. Horizontal compression rather than vertical displacement is its characteristic feature. Cf. *normal fault*, *Partial syn reverse fault*, *Syn thrust overthrust*.

**thrust plane** Any surface of a thrust fault that is planar

**thrust sheet** The body of rock above a large-scale thrust fault whose surface is horizontal or very gently dipping.

**thrust slice** A relatively thin body of rock bounded above and below by thrust faults within a zone of thrusting. Syn. *slice*.

**thunder egg** A popular term for a small, geodelike body of chalcedony, opal, or agate that has weathered out of the welded tuffs of central Oregon

**tidal bore** (tid'-al) *bore*.

**tidal channel** 1. A major channel followed by tidal currents, extending from offshore into a tidal marsh or a flat. 2. *tidal inlet*



**tidal compartment** That portion of a stream which intervenes between the area of unimpeded tidal action and that in which there is a complete absence of tidal action

**tides' constant** Either of two parameters, which combined completely specify a simple tide, the first is the amplitude (elevation above mean sea level) and the second is the epoch (time between the moon's meridian passage and the ensuing high tide)

**tidal correction** A correction applied to gravitational observations to remove the effect of earth tides

**tidal datum** A plane defined by reference to a certain phase of the tide

**tidal delta** Deltas formed at the seaward and lagoonal mouths of a tidal inlet by tidal currents that sweep sand in and out of the inlet

**tidal flat** An extensive, nearly horizontal, marshy or barren tract of land that is alternately covered and uncovered by the tide, and consisting of unconsolidated sediment (mostly mud and sand). It may form the top surface of a deltaic deposit. See also *tidal marsh*, *mud flat*.

**tidal friction** The frictional effect of the tides, especially in shallow waters, lengthening the tidal epoch and tending to retard the rotational speed of the earth and so increase very slowly the length of the day

**tidal inlet** Any inlet through which water flows alternately landward

with the rising tide and seaward with the falling tide; specif a natural inlet maintained by tidal currents. Syn *tidal outlet*, *tidal channel*.

**tidal marsh** A marsh bordering a coast (as in a shallow lagoon or sheltered bay), formed of mud and of the resistant mat of roots of salt-tolerant plants, and regularly inundated during high tides, a marshy *tidal flat*. Cf *salt marsh*.

**tidal pool** A pool of water remaining on a beach or reef after recession of the tide

**tidal prism** The total amount of water that flows into a harbor or out again with movement of the tide, excluding any freshwater flow

**tidal range** The difference between the level of water at high tide and low tide

**tidal river** A river whose lower part for a considerable distance is influenced by the tide of the body of water into which it flows, the movement of water in and out of an estuary or other inlet as a result of the alternating rise and fall of the tide.

**tidal wave** An erroneous syn of both *storm surge* and *tsunami*.

**tide** 1. The rhythmic, alternate rise and fall of the surface of the ocean, occurring twice a day over most of the earth, and resulting from the gravitational attraction of the moon (and, in lesser degree, of the sun) acting unequally on different parts of the rotating earth. 2. *earth tide*.

**tied island** An island connected to the mainland or to another island by a *tombolo*.

**tiger's-eye** A chatoyant yellowish-brown gem and ornamental variety of quartz, pseudomorphous after crocidolite, whose fibers (penetrating the quartz) are changed to iron oxide (limonite); silicified crocidolite stained yellow or brown by iron oxide

**tight fold** A fold with an inter-limb angle between 0° and 30°.

**tight hole** A drilling or completed well about which information is kept secret by the operator

**tight sand** A sand whose interstices are filled with fine grains or with matrix material, thus effectively destroying porosity and permeability. The term is used in petroleum geology

**till** Unstratified drift, deposited directly by a glacier without reworking by meltwater, and consisting of a mixture of clay, silt, sand, gravel, and boulders ranging widely in size and shape Cf *stratified drift*. See also: *moraine*, *boulder clay*

**tillite** (till'-ite) A sedimentary rock formed of lithified glacial till, esp pre-Pleistocene till (such as the Late Carboniferous tillites in South Africa and India).

**till plain** An extensive area, with a flat to undulating surface, underlain by till with subordinate end moraines, such plains occupy parts of Indiana, Illinois, and Iowa

**tilt block** A *fault block* that has become tilted, perhaps by rota-

tion on a hinge line.

**time** 1. Measured or measurable duration; a nonmaterial dimension of the universe, representing a period during which an action or condition exists or continues. See: *geologic time*. 2. A reference point from which duration is measured, e.g. the instant at which a seismic event occurs relative to a chosen reference time such as a shot instant. 3. Any division of geologic chronology, such as "Paleozoic time" or "Miocene time".

**time break** *shot break*.

**time-depth chart** A graphical expression of the relation between velocity and arrival time of vertically travelling seismic reflections. It permits the time increments to be converted to the corresponding depths. Syn: *time-depth curve*

**time-depth curve** *time-depth chart*.

**time-distance curve** In seismology, a plot of wave-train travel time against corresponding distance along the earth's surface from the source to the point of observation. Abbrev. T.D. curve

**time domain** Measurements as a function of time, or operations in which time is the variable, in contrast to the *frequency domain*.

**time lag** A delay in the arrival time of seismic energy from the time expected. Time lags may be produced by an abnormal low-velocity layer, phase shifts in filtering, or other factors.

**time lead** The arrival of seismic energy earlier than expected, in-

indicating that part of the travel path involved high velocity. It is an indication of a salt dome in *fan shooting*. Syn. *lead*.

**time line** A line indicating equivalence in age in a geologic cross section or correlation diagram.

**time plane** A stratigraphic horizon denoting a "instant" in geologic time.

**time-rock unit** *chronostratigraphic unit*.

**time section** A graphical representation of reflection seismic records taken along a line in which the vertical scale is two way seismic travel time and the horizontal scale is surface distance.

**time stratigraphic** Said of rock units with boundaries based on geologic time, as with synchronous boundaries.

**time tie** The identification of seismic events in different records by their arrival times, when they possess common raypaths.

**time-transgressive** *diachronous*.

**time value** The interval of geologic time represented by or involved in producing a stratigraphic unit, an unconformity, the range of a fossil, or any geologic feature or event. See also *hiatus*.

**Timiskamian** (Ti-mis-kam-i-an) A division of the Archeozoic of the Canadian Shield. Also spelled *Timiskaming*.

**tin** 1 A bluish-white mineral, the native metallic element Sn. 2 A term used loosely to designate cassiterite and concentrates containing cassiterite with minor amounts of other minerals.

**tincal** (tin'-cal) An old name for crude *borax* formerly obtained from Tibetan lake shores and deposits and once the chief source of boron compounds.

**tinestone** *cassiterite*.

**titaniferous** (ti-tan-iff'-er-ous) Containing titanium, as titaniferous iron ore, e.g. *ilmenite*.

**titanite** (ti'-ta-nite) *sphen*.

**toe** 1 The downslope edge of a landslide or slump. 2 The lowest part of a slope or cliff, the down-slope end of an alluvial fan. 3 The leading edge of a thrust sheet. 4 A bulbous projection at the front of a moving flow of *pahoehoe* lava, formed by the breaking open of the crust and the emergence of fluid lava. 5 Along a coast, a nearly horizontal strip of gravel or sand that divides the beach from the shoreface. 6 The bottom of a drill hole, esp. one used for blasting.

**tombolo** (ton-'bo'-lo) A bar or barrier that connects an island with the mainland or with another island. 1 mol. Italian "sand dune", from Latin *tumulus*, "mound".

**tonalite** (to'-nal-ite) *quartz diorite*.

**tongue** 1 A minor lithostratigraphic unit of limited extent, esp. a member that extends outward beyond the main body of a formation and appears laterally usually by facies change. See also *intertonguing*, *lenticle*. 2 Any projection, extension, or offshoot, as a *glacier tongue*, a branch of a large intrusive body, a lava flow extending from a larger flow, or an

extension of one type of ocean water into water of differing salinity or temperature, e.g. salt water into the mouth of a river

**tool mark** A current mark produced by the impact against a muddy bottom of a solid object swept along by the current, and generally preserved as a cast on the underside of the overlying bed. The engraving "tools" include shell fragments, sand grains, pebbles, fish bones, seaweed, and wood chips

**toolpusher** The general supervisor of operations on a *drilling rig*

**top** In petroleum geology, the uppermost surface of a formation encountered during drilling, usually characterized by a change in lithology or fossil content. It is often recognized by a distinctive configuration or "kick" on an electric log, and is widely used in correlation and structure-contour mapping

**topaz** (to'-paz) 1. An orthorhombic mineral,  $\text{Al}_2\text{SiO}_4(\text{F}, \text{OH})_2$ . It occurs as a minor constituent in siliceous igneous rocks and tin-bearing veins as translucent or transparent prismatic crystals and masses, and as rounded waterworn pebbles. Topaz has a hardness of 8 on the Mohs scale. 2. A transparent topaz used as a gemstone and the birthstone for November

**topaz quartz** The yellow variety of quartz, *citrine*, used as a gem

**topocline** (top'-o-cline) A *cline* related to a geographic zone and usually unrelated to any ecologic

condition

**topographic adjustment** (top-ograph'-ic) The condition existing where the gradient of a tributary is harmonious with that of the main stream

**topographic adolescence** *adulthood*

**topographic correction** terrain correction

**topographic map** A map showing the topographic features of a land surface, commonly by means of contour lines. It is generally on a sufficiently large scale to show in detail selected man-made and natural features, including relief and such physical and cultural features as vegetation, roads, and drainage. Cf. *planimetric map*

**topographic maturity** *maturity*

**topographic old age** *old age*

**topographic texture** Disposition, grouping, or average size of the topographic units composing a given topography, usually restricted to a description of the relative spacing of drainage lines in stream-dissected regions. See also *coarse topography*, *drainage density*, *syn texture*

**topographic unconformity** 1. The relationship between two parts of a landscape or two kinds of topography that are out of adjustment with one another, due to an interruption in the ordinary course of the erosion cycle of a region, e.g. a lack of harmony between the topographic forms of the upper and lower parts of a valley, due to rejuvenation. 2. A land surface exhibiting topo-

graphic unconformity.

**topographic youth** youth.

**topography** (to-pog'-ra-phy) The general configuration of a land surface, including its relief and the position of its natural and man-made features. Etymol:

Greek *topos*, "place", + *graph-ein*, "to write".

**topology** (to-pol'-o-gy) 1. The analytical, detailed study of minor landforms, requiring fairly large scales of mapping. 2. The topographic study of a particular place; specif. the history of a region as indicated by its topography.

**topotype** (top'-o-type) A specimen of a particular species that comes from the same locality as the type specimen of that species.

**topset bed** One of the nearly horizontal layers of sediment deposited on the top surface of an advancing delta and continuous with the landward alluvial plain, it truncates or covers the edges of the seaward-lying *foreset beds*. See also: *bottomset bed*.

**topsoil** The fertile, dark-colored surface soil, or A horizon.

**tor** A high, isolated crag, pinnacle, or rocky peak; or a pile of rocks, much-jointed and usually granitic, e.g. the granite rocks standing as prominent masses on the moors of Devon and Cornwall, England. Etymol: Celtic(?).

**torbanite** (tor'-ban-ite) Essentially synonymous with *boghead coal*, but often considered as a highly carbonaceous oil shale. It is named from its type locality, Tor-

bane Hill, in Scotland.

**Toreva block** (To-re'-va) A slump block consisting essentially of a single large mass of unjostled material which, during descent, has undergone a backward rotation toward the parent cliff about a horizontal axis that roughly parallels it. See also: *rotational landslide*.

**torque** The effectiveness of a force that tends to rotate a body, the product of the force and the perpendicular distance from its line of action to its axis.

**torrent** A stream of water flowing with great velocity or turbulence, as after a heavy rainfall or down a steep incline; a cascade. Also, any similar stream, as of lava. Adj. *torrential*.

**torrential cross-bedding** (tor-ren'-tial) A variety of *angular cross-bedding* in which the beds make a nearly uniform but relatively large angle with the layers that enclose them. It is essentially planar cross-bedding.

**torsion** (tor'-sion) The state of stress produced by two force couples of opposite moment acting in different but parallel planes about a common axis.

**torsion balance** A geophysical prospecting instrument for measuring distortions in the gravitational field, by determining the amount of twisting or torsion they cause in a slender wire or filament. Syn: *Eötös torsion balance*.

**torsion coefficient** A measure of the resistance offered by a materi-

al to a torsional stress.

**torsion fault** *wrench fault*.

**torsion period** The natural period of oscillation of the suspended system in a torsion balance.

**tortuosity** (tor-tu-os'-i-ty) 1. The ratio of the actual length of a river channel, measured along the middle of the main channel, to the axial length of the river. 2. The inverse ratio of the length of a rock specimen to the length of the equivalent path of electrolyte within it.

**total depth** (to'-tal) The greatest depth reached by a well bore, measured along its axis, not necessarily a vertical depth. Abbrev. TD.

**total displacement** *slip*.

**total field** The vector sum of all components of a field, such as the magnetic or gravitational fields. Syn. *total intensity*.

**total intensity** *total field*.

**total porosity** *porosity*.

**total reflection** *Reflection* in which all of the incident wave is returned.

**total time correction** The sum of all corrections applied to reflection travel time in seismic prospecting, to express times as those that would have been obtained if source and detectors were located on a selected datum plane, in the absence of a low-velocity layer or variations in elevation.

**tourmaline** (tour'-ma-line) A group of minerals of general formula  $(\text{Na,Ca})(\text{Mg,Fe}^{+2},\text{Fe}^{+3},\text{Al,Li})_3\text{Al}_6(\text{BO}_3)_3\text{Si}_6\text{O}_{18}(\text{OH})_4$ , it sometimes contains fluorine in

small amounts. Also, any mineral of the tourmaline group. Tourmaline occurs in 3-, 6-, or 9-sided prisms, usually vertically striated, or in compact or columnar masses, it is commonly found as an accessory mineral in granitic pegmatites, and is widely distributed in acid igneous rocks and in metamorphic rocks. When transparent and flawless, it may be cut into gems. See also *schorl*. **township** The unit of survey of the U.S. Public Land Survey system, representing a piece of land that is bounded on the east and west by meridians approximately six miles apart and on the north and south by parallels six miles apart, and that is normally subdivided into 36 sections, each approximately one mile square.

**township line** One of the imaginary boundary lines running east and west at six-mile intervals and marking the relative north and south locations of townships in a U.S. public-land survey. Cf. *range line*.

**T phase** A seismic phase with a period of 1 sec or less, which travels through the ocean with the speed of sound in water. It is occasionally identified on the records of those earthquakes in which a large part of the path from epicenter to station is across the deep ocean.

**T plane** A term used in crystal plasticity to denote the crystallographic slip plane. See also *f* axis, *t* direction. Syn. *glide plane*, *translation plane*.

**trace** 1 A concentration or amount that is too small for accurate quantitative determination. 2 A mark left behind by an extinct animal: see *trace fossil*. 3 In sermology, the record of the output of a geophone group with time after the shot, displayed on paper, film, or tape. 4 The line along which a geological surface intersects another surface: e.g. the trace of bedding on a fault surface, or the trace of a fault on the ground. Cf. *trend*.

**trace element** 1 An element that is not essential in a mineral but that is found in small quantities in its structure or adsorbed on its surfaces. Although not quantitatively defined, it is conventionally assumed to constitute significantly less than 1 G% of the mineral. Syn. *accessory element*. 2 An element that occurs in minute quantities in plant or animal tissue and that is essential physiologically.

**trace fossil** A sedimentary structure consisting of a fossilized track, trail, burrow, or tube resulting from the life activities of an animal, such as a mark made by an invertebrate creeping, feeding, hiding, or resting on or in soft sediment. It is often preserved as a raised or depressed form in sedimentary rock. Many trace fossils were formerly assumed to be bodily preserved plants or animals. Syn. *ichnofossil*, *trace*.

**trace slip** In a fault, that component of the net slip which is parallel to the trace of an index plane, such as bedding, on the fault

plane. See also *trace-slip fault*. **trace-slip fault** A fault on which the net slip is *trace slip*, parallel to the trace of the bedding or other index plane on the fault surface.

**trachyandesite** (tra'-chy an'-de-site) An extrusive rock, intermediate in composition between trachyte and andesite, with sodic plagioclase, alkali feldspar, and one or more mafic minerals (biotite, amphibole, or pyroxene). Cf. *latite*.

**trachybasalt** (tra'-chy-ba-salt) An extrusive rock intermediate in composition between trachyte and basalt, characterized by the presence of both calcic plagioclase and alkali feldspar, along with clinopyroxene, olivine, and possibly minor analcime or leucite. Cf. *latite*.

**trachyte** (tra'-chyte) A group of fine-grained, generally porphyritic extrusive rocks having alkali feldspar and minor mafic minerals (biotite, hornblende, or pyroxene) as the main components, and possibly a small amount of sodic plagioclase, also, any member of that group, the extrusive equivalent of *syenite*. Etymol. Greek *trachys* "rough".

**trachytic** (tra'-chy'-ic) 1 A textural term applied to volcanic rocks in which feldspar microclites of the groundmass have a subparallel arrangement corresponding to the flow lines of the lava from which they were formed. Cf. *trachytoid*, *pliotaxitic*, *orthophyric*. 2 Pertaining to or composed of *trachyte*.

**trachytoid** (trach' y-toid) Said of the texture of a phaneritic igneous rock (esp. nepheline syenite) that recalls the *trachytic* texture of some lava flows

**track** A fossil structure consisting of a mark left in soft material by the foot of an animal Cf. *trail*

**traction** (trac'-tion) Sediment transport in which particles are rolled, dragged, or pushed along a stream bottom or on a desert surface or a beach Cf. *suspension*

**traction load** *bed load*

**tractive current** (trac-tive) A current in standing water, which transports sediment along and in contact with the bottom, as in a stream Cf. *turbidity current*

**trail** 1 The trace or mark left by a moving organism, e.g. a worm trail Cf. *track* 2 A line or belt of rock fragments picked up by glacial ice at a localized outcrop and left scattered along a more or less well-defined path during movement and melting of the glacier Cf. *boulder train* 3 Crushed material along a fault surface that is used as an indication of the direction of displacement Such material can be the source of mineral deposits

**train** 1 A narrow glacial deposit extending for a long distance such as a *valley train* or a *boulder train* 2 A series of oscillations on a seismograph record

**transcurrent fault** (trans-cur-rent) A large-scale *strike slip fault* in which the fault surface is steeply inclined

**transection glacier** (tran-sec'-tion)

A glacier that fills an entire valley system, concealing the divides between the valleys Cf. *through glacier*

**transfer** A single process occurring continuously in space-time in which erosion is followed by transportation and deposition of sediment

**transfer percentage** For any element the ratio of the amount present in sea water to the amount supplied to sea water during geologic time by weathering and erosion multiplied by 100

**transformation** (trans-for-ma'-tion) 1 The change of one crystal polymorph to another, by any of several processes Syn. *inversion* 2 The *transmutation* of one element into another 3 *granitization*

**trans-formational breccia** (trans-for-ma'-tion-al) A breccia occurring in a vertical body cutting through a stratigraphic section, believed to have been produced by collapse, as above a dissolved salt bed

**transform fault** 1 A special variety of *strike slip fault* along which the displacement suddenly stops or changes form Many transform faults are associated with *mid oceanic ridges*, where the actual slip is opposite from the apparent displacement across the fault 2 A *plate boundary* that ideally shows pure strike-slip displacement

**transformism** (trans-form'-ism) A theory that explains the origin of granite as a result of *granitization*,



opposed to *magmatism*.

**transformist** A proponent of the theory of *transformism*

**transgression** (trans-gres'-sion) 1

The spread of the sea over land areas, also, any change that brings offshore, deep-water environments to areas formerly occupied by nearshore shallow-water conditions, or that shifts the boundary between marine and nonmarine deposition outward from the center of a marine basin. Ant. *regression*. Cf. *onlap*. Syn. *invasion*, *marine transgression*. 2 A term used mostly in Europe for discrepancy in the boundary lines of continuous strata i.e. *unconformity*

**transgressive reef** (trans-gres'-sive) One of a series of nearshore reefs or bioherms superimposed

on back-reef deposits of older reefs during the sinking of a land-mass or a rise of the sea level, and developed more or less parallel to the shore. Cf. *regressive reef*

**transit** (tran'-sit) *n* A *theodolite* in

which the telescope can be reversed in its supports by rotating it 180 degrees about its horizontal transverse axis — *v* To reverse the direction of the telescope of a transit by rotating it 180 degrees about its horizontal axis. Syn. *plunge*

**transition zone** (tran-si'-tion) 1 A

region within the *upper mantle* bordering the lower mantle, at a depth of 410-1000 km, characterized by a rapid increase in density of about 20% and an increase in seismic-wave velocities, it is

equivalent to the *C layer*. 2. A region within the *outer core*, transitional to the inner core; the *F layer*. — The term may refer to several zones of rapid increase in seismic velocity corresponding to phase or chemical changes

**translation** (trans-la'-tion) A shift in position without rotation

When applied to plastic deformation, it refers to the movement of one block of atoms past another

**translational fault** (trans-la'-tional)

A fault in which there has been translational movement and no rotational component of movement, dip in the two walls remains the same. It can be strictly applied only to segments of faults

See also *translational movement*

**translational movement** Apparent

fault-block displacement in which the blocks have not rotated relative to one another, so that features that were parallel before movement remain so afterwards. Cf. *rotational movement*. See also *translational fault*

**translation gliding** Deformation of

crystalline material, produced by either compression or tension, in which displacement on preferred lattice planes takes place without reorientation or rupture of the deformed parts. It often produces crystal twins. Syn. *crystal gliding*, *twin gliding*

**translation plane** *T plane*

**translucent** (trans-lu'-cent) Said of

a mineral that is capable of transmitting light, but is not *transparent*. Cf. *opaque*.

**transmission constant** (trans-mis'-

sion) An expression of the ability of a permeable medium to transmit a fluid under pressure. As applied to ground water, the discharge in cubic feet per minute through each square foot of cross-sectional area under a 100 percent hydraulic gradient.

**transmission electron microscope** An electron-optical microscope that utilizes an assembly of magnetic lenses and a beam of high-energy electrons that are transmitted through the specimen. The main advantage is high resolution, which results from the very small wave lengths of electrons. Abbrev. TEM.

**transmissivity** (trans-mis-siv-i-ti) The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Although spoken of as a property of the aquifer, it embodies also the saturated thickness and the properties of the contained liquid.

**transmutation** (trans-mu-ta'-tion) 1. The transformation of one element into another. Radioactive decay is an example. 2. The evolutionary change from one species to another.

**transparent** (trans-par'-ent) said of a mineral that is capable of transmitting light, and through which an object may be seen. Cf. *translucent*, *opaque*.

**transpiration** (tran-spi-ra'-tion) The process by which water absorbed by plants, usually through the roots, is evaporated into the

atmosphere from the plant surface.

**transport** (trans-'port) A syn. of *transportation*, esp. in British usage. It occurs in such terms as *mass transport*.

**transportation** (trans-por-ta'-tion) The movement of sediment by natural agents (such as flowing water, ice, wind, or gravity) either as solid particles or in solution from one place to another on the earth's surface, e.g., the drifting of sand along a seashore under the influence of currents. Syn. *transport*.

**transported** (trans-ported) Said of material that has been carried by natural agents from its former site to another place on or near the earth's surface.

**transverse** Extended in a crosswise direction, esp. said of a topographic feature oriented at right angles to the general strike or trend of a region. Ant. *longitudinal*.

**transverse crevasse** A crack in a glacier, and proximately at right angles to the direction of ice flow.

**transverse dune** A strongly asymmetrical ridge of sand extending transversely to the direction of the prevailing winds, having a gentle windward slope and a steep leeward slope standing at or near the angle of repose of the sand.

**transverse fault** A fault that strikes obliquely or perpendicular to the general structural trend of the region.

**transverse joint** A joint that is transverse to the strike of the strata.

ta or schistosity

**transverse valley** A valley having a direction at right angles to the general strike of the underlying strata Cf *longitudinal valley*

**transverse wave** *S wave*

**trap** Any dark fine-grained igneous rock such as basalt or diorite. Also any such rock used as a building stone. Etymol Swedish *trappa* 'stair step' in reference to the steplike appearance created by the abrupt termination of successive flows. Syn *trap rock* - *oil trap*

**trap-door fault** A curved fault bounding a block that is hinged along one edge. It is an *intrusion displacement* structure in the Little Rocky Mountains of Montana

**trapezohedron** (*tra pe zo he don*) 1 An isometric crystal form of 24 faces, each face of which is ideally a four-sided figure having no two sides parallel or a trapezium. 2 A crystal form consisting of six, eight or twelve faces, half of which above are offset from the other half below. Each face is, ideally, a trapezium. The tetragonal and hexagonal forms may be right- or left-handed

**trap rock** *trap*

**traverse** (*trav-erse*) *n* 1 A line surveyed across a plot of ground, esp an accurately plotted series of lines end to end often used as a basis for triangulation. 2 A passing across or through as a *traverse* of a mountain range. 3 A line across a thin section or other

sample along which grains of various minerals are counted or measured - To make a traverse - *a traverse survey*

**travertine** (*trav'er-tine*) A finely crystalline massive deposit of calcium carbonate of white, tan, or cream color, formed by chemical precipitation from solution in surface and ground waters as around the mouth of springs esp hot springs. It also occurs in limestone caves where it forms stalactites and stalagmites. A spongy or less compact variety is *tufa*. See also *onyx marble*. Etymol Italian *tivertino* from the old Roman name of Tivoli, a town near Rome where travertine forms an extensive deposit

**tread** The flat or gently sloping surface of one of a series of natural steplike landforms such as those of a glacial stairway or of successive stream terraces, a bench level Cf *riser*

**tree ring** *growth ring*

**trellis drainage pattern** An arrangement of surface drainage characterized by parallel main streams that have right angle tributaries, which in turn are fed by elongated secondary tributaries parallel to the main streams, it resembles in plan the stems of a vine on a trellis. It is commonly developed where the beveled edges of alternating hard and soft rocks outcrop in parallel belts, and is indicative of marked structural control shown by subsequent and secondary consequent streams. Examples are well dis-

played in the Appalachian Mountains region. Cf: *rectangular drainage pattern*.

**tremolite** (trem'-o-lite) A white to dark-gray monoclinic mineral of the amphibole group:  $\text{Ca}_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2$ . It occurs in long blade-shaped or short stout prismatic crystals, and also in columnar or fibrous masses, esp. in metamorphic rocks such as crystalline dolomitic limestone and talc schist. It is a constituent of much commercial talc.

**tremor** (trem'-or) A minor earthquake, esp a foreshock or an aftershock.

**trench** 1. A long, straight depression between two mountain ranges, often occupied by two streams that drain in opposite directions. Syn: *trough*. 2. A long, narrow excavation, natural or artificial, in the earth's surface. 3. A narrow, elongate depression of the deep-sea floor, with steep sides, oriented parallel to the trend of the continent and lying between continental margin and abyssal hills. It is about 2 km deeper than the surrounding ocean floor and may be thousands of kilometers long. Syn: *marginal trench*. Cf: *trough*.

**trend** 1. A general term for the direction or bearing of the outcrop of a geological feature, such as an ore body, fold, or orogenic belt. Cf: *strike*; *trace*. 2. That component in a geophysical anomaly map which is relatively smooth, generally produced by regional geological features. 3. In paleon-

tology, the evolution of a specific structure or characteristic within a group, esp. a large group such as an order or class; e.g. the evolution of the form of the septal suture in the ammonoids from Devonian to Triassic.

**triangular diagram** (tri-an'-gu-lar) A method of plotting compositions in terms of the relative amounts of three materials or components, involving an equilateral triangle wherein each apex represents a pure component. The perpendicular distances of a point from each of the three sides will then represent the relative amounts of each of the three materials represented by the apexes opposite those sides.

**triangular facet** A physiographic feature, having a broad base and an apex pointing upward, specif the face on the end of a *faceted spur*, usually a remnant of a fault plane at the base of a block mountain. A triangular facet may also form by wave erosion of a mountain front or by glacial truncation of a spur between valleys.

**triangulate** (tri-an'-gu-late) To divide into triangles; esp. to survey or map by triangulation.

**triangulation** (tri-an'-gu-la'-tion) A method of surveying in which the stations are points on the ground at the vertices of a network of triangles; it is generally used where the area surveyed is large and requires the use of geodetic methods.

**Triassic** (Tri-as'-sic) The first period of the Mesozoic era (after the

Permian of the Paleozoic era, and before the Jurassic), thought to have covered the span of time between 225 and 190 million years ago, also, the corresponding system of rocks. The Triassic is so named because of its threefold division in the rocks of Germany.

**tributary** (trib'-u-tar-y) Any stream that contributes water to another stream. Svn. *feeder* Ant: *distributary*.

**trichroism** (tri'-chro-ism) *Pleochroism* of a crystal that is indicated by three colors. A mineral showing trichroism is said to be *trichroic*. Cf. *dichroism*.

**triclinic system** (tri-clin'-ic) One of the six crystal systems, characterized by a onefold axis of symmetry and having three axes that are unequal and mutually oblique. Triclinic crystals lack symmetry other than a possible center.

**tridymite** (trid'-y-mite) A mineral.  $\text{SiO}_2$  It is a high-temperature polymorph of quartz, and usually occurs as minute tabular white or colorless crystals or scales, in cavities in acidic volcanic rocks. Tridymite is stable between 870° and 1470°C. Cf. *cristobalite*.

**trigonal system** (trig'-o-nal) A crystal system of threefold symmetry that is often considered as part of the hexagonal system since the lattice may be either hexagonal or rhombohedral. See also: *rhombohedral system*.

**trigonometrical survey** (trig'-o-nomet'-ri-cal) A survey made by triangulation and by calculating the elevations of points of obser-

vation. It is generally preliminary to a topographic survey.

**trilobite** (tri'-lo-bite) Any marine arthropod belonging to the class Trilobita, characterized by a three-lobed ovoid outer skeleton, divided lengthwise into axial and side regions and transversely into cephalon ("head"), thorax (middle), and pygidium ("tail"). Range. Lower Cambrian to Permian.

**trimline** A sharp boundary line delimiting the maximum upper level of the margins of a glacier that has receded from an area.

**trimorphism** (tri-mor'-phism) That type of *polymorphism* in which there are three crystal forms, known as trimorphs. Adj: *trimorphous*. Cf. *dimorphism*.

**trimorphous** (tri-mor'-phous) Adj of *trimorphism*.

**trioctahedral** (tri'-oc-ta-he'-dral) Pertaining to a layered-mineral structure in which all possible octahedral positions are occupied. Cf. *dioctahedral*.

**tripartite method** (tri-par'-tute) A method of determining the apparent surface velocity and direction of propagation of microseisms or earthquake waves by determining the times at which a given wave passes three separated points.

**triple junction** A point where three lithospheric plates meet

**tripoli** (trip'-o-li) 1. A light-colored porous friable siliceous sedimentary rock, which occurs in powdery or earthy masses that result from the weathering of chert or siliceous limestone. It has a

harsh, rough feel, and is used as a polish. 2 A term incorrectly applied to a siliceous earth that closely resembles tripoli, specif *diatomite*.

**trisoctahedron** (tris'-oc ta he' dron) An isometric crystal form of 24 faces, each of which is an isosceles triangle.

**tritium** (tri' i um) A radioactive isotope of hydrogen having two neutrons and one proton in the nucleus.

**trivariant** (tri var-i ant) Pertaining to a system having three degrees of freedom, i.e. having a variance of three.

**troilite** (tro' i lite) A hexagonal mineral, FeS, a variety of pyrrhotite that is present in small amounts in almost all meteorites.

**trona** (tro' na) A white or yellow-white monoclinic mineral,  $\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$ . It occurs in fibrous or columnar layers and thick beds in saline residues. Trona is a major source of sodium compounds.

**troposphere** (tro' po-sphere) That portion of the atmosphere next to the earth's surface, in which temperature generally decreases rapidly with altitude, clouds form, and convection is active. In middle latitudes the troposphere includes the first 10 to 12 km above the earth's surface. Cf. *stratosphere*.

**trough** 1 Any long, narrow depression in the earth's surface, esp a *glacial trough* or a *trench*. 2 An elongate depression in the sea floor that is wider and shall

lower than a trench. A trough may develop from a trench by becoming partially filled with sediment. 3 A small linear depression formed just offshore on the bottom of a sea or lake and on the landward side of a longshore bar. 4 An informal syn. of *graben*. 5 An informal syn. of *geosyncline*.

**true dip** A syn. of *dip* used in comparison with *apparent dip*.

**true north** The direction from any point on the earth's surface toward the geographic north pole, the northerly direction of any geographic meridian or of the meridian through the point of observation. It is the universal zero degree (or 360-degree) mapping reference. True north differs from magnetic north by the amount of magnetic declination at the given point.

**true thickness** The thickness of a stratigraphic unit or other tabular body, measured at right angles to the direction of extension of the unit or body. Cf. *apparent thickness*.

**truncate** (trun'-cate) v. 1 To cut off or shorten. 2 In crystal structure to replace the corner of a crystal form with a plane. Such a crystal form is said to be truncated.

**truncated spur** (trun'-cat-ed) A spur that projected into a periglacial valley and was partially worn away or beveled by a moving glacier that widened and straightened the valley. See also *faceted spur*.

**truncation** (trun ca' tion) The cut-

ring-off or removal of a part of a geologic structure or landform, as by erosion Cf *beveling*

**trunk glacier** The main ice stream in a system of valley glaciers

**tsunami** (tsu na'-mi [tsoo nah'-me]) A great sea wave produced by a submarine earthquake or volcanic eruption. It is characterized by great speed of propagation (up to 950 km/hr), long wavelength (up to 200 km), long period (varying from 5 min to a few hours, generally 10-60 min), and low observable amplitude on the open sea, although it may pile up to heights of 30 m or more and cause much damage on entering shallow water along an exposed coast (often thousands of kilometers from the source). Etymol. Japanese "harbor wave." Syn. *sea wave*, *harmonic sea wave*, *at wave*

**tubing** A small-diameter, nonflexible pipe, suspended and mineralized in a well inside a large diameter casing and opened at a producing zone through which fluids are brought to the surface.

**tufa** A chemical sedimentary rock composed of calcium carbonate formed by evaporation as an incrustation around the mouth of a spring, along a stream, or exceptionally as a thick, concretionary deposit in a lake or along its shore. It may also be precipitated by algae or bacteria. The hard, dense variety is *travertine*. The term is not to be confused with *tuff*. Cf *sinter*. Syn. *calcareous tufa*

**tuff** A general term for all consolidated pyroclastic rocks. Not to be confused with *tufa*. Adj. *tuffaceous*

**tuffite** (tuff'-ite) A tuff containing both pyroclastic and detrital material, but predominantly pyroclasts

**tufflava** (tuff-la'-va) An extrusive rock containing both pyroclastic and lava-flow characteristics, so that it is considered to be an intermediate form between a lava flow and a welded-tuff type of *ignimbrite*

**tumescence** ('u-nies-cence) The swelling or uparching of a volcano during periods of rising maxima preceding an eruption

**tundra** (tun-dra) A level or undulating treeless plain characteristic of arctic regions, having a black muck soil and a permanently frozen subsoil

**tungstate** (tung'-state) A mineral compound characterized by the radical  $\text{WO}_4$ , in which the hexavalent tungsten ion and the four oxygens form a flattened square rather than a tetrahedron. An example of a tungstate is wolframite,  $(\text{Fe Mn})\text{WO}_4$ . Tungsten and molybdenum may substitute for each other. Cf *molybdate*

**tunnel** 1. Strictly speaking, a passage in a mine that is open at both ends. In practice it is often used as a syn. of *adit* or *drift*. 2. *natural tunnel*

**tunnel valley** A shallow trench cut in drift and other loose material, or in bedrock, by a subglacial stream not loaded with coarse

sediment

**turbid** (tur'-bid) Stirred up or disturbed, as by sediment, opaque with suspended matter, such as a sediment-laden stream, or cloudy in physical appearance, such as a feldspar containing minute inclusions

**turbidimeter** (tur bi-dim'-e-ter)

An instrument for measuring the turbidity of a liquid in terms of the reduction in intensity of a light beam passing through it

**turbidite** (tur'-bid ite) A sediment deposited from a turbidity current. It is characterized by graded bedding, moderate sorting, and well developed primary structures, esp lamination

**turbidity current** (tur bid'-i-ty) A

density current in water or air specif a bottom flowing current laden with suspended sediment, moving swiftly down a subaqueous slope and spreading horizontally on the floor of the body of water, having been set in motion by locally stirred-up sediment that gives the water a density greater than that of the surrounding clear water. Such currents are known to occur in lakes, and are believed to have produced the submarine canyons notching the continental slope. The term is applied to a current due to turbidity, not to one showing that property. Cf *tractive current*. Syn *suspension current*

**turbidity size analysis** A kind of particle-size analysis based on the amount of material in turbid suspension, the turbidity decreasing

as the particles settle

**turbodrift** (tur'-bo-drift) In *rotary drilling*, a drill bit that is directly rotated by a turbine attached to the drill pipe at the bottom of the hole and driven by drilling mud pumped under high pressure. It was developed in the U S S R for drilling deep oil wells

**turbulence** (tur bu-lence) *turbulent flow*

**turbulent flow** (tur' bu lent) Water flow in which the flow lines are confused and heterogeneously mixed. It is typical of flow in surface-water bodies. Cf *laminar flow*. Syn *turbulence*.

**turnover** 1 A period, usually in the fall or spring, of uniform vertical temperature when convection circulation occurs in a lake, the time of an *overtum*. See also *circulation*. 2 The process by which some species become extinct in a region and are replaced by other species, also, the number of animal generations that replace each other during a given length of time

**turquoise** (tur'-quoise) A trichlorine mineral,  $\text{CuAl}_6(\text{PO}_4)_4(\text{OH})_8 \cdot 5\text{H}_2\text{O}$ . It is blue, blue-green, or yellowish green, when sky blue it is valued as the most important of the nontransparent gem materials and the birthstone for December. It usually occurs as reniform masses with a *botryoidal* surface, in the zone of alteration of aluminum-rich igneous rocks such as trachytes.

**turtleback** An extensive smooth curved topographic surface, ap-



parently unique to the Death Valley region, California, that resembles the carapace of a turtle; it is a large elongate dome with an amplitude up to a few thousand meters.

**turtle stone** A flattened oval *separatum* released from its matrix and so weathered that the vein-filled system of cracks may be seen. Its form has a rough resemblance to that of a turtle and its polished surface bears a fancied resemblance to a turtle's back. Such concretions are present in the Devonian shales of eastern North America.

**twin** A rational intergrowth of two or more single crystals of the same mineral in a mathematically describable manner, so that some lattices are parallel whereas others are in reversed position. The symmetry of the two parts may be reflected about a common plane, axis, or center. See also *twinning*.

**twin gliding** *Crystal gliding* that results in the formation of crystal twins. Syn. *translation gliding*.

**twin law** A definition of a twin relationship in a given mineral or mineral group, specifying the twin axis, center, or plane, defining the composition surface or plane if possible, and giving the type of twin.

**twinning** The formation of *twin* crystals.

**twinning axis** The crystal axis about which one individual of a twin crystal may be rotated, usually 180°, to bring it into coincidence with the other individual. It

cannot be coincident with the axes of twofold, fourfold, or sixfold symmetry. Cf. *twinning plane*.

**twinning displacement** Displacement in a crystal due to twin gliding.

**twinning plane** The common plane across which the individual components of a crystal twin are symmetrically arranged or reflected. It is parallel to a crystal face but not to a plane of symmetry of a single crystal. It is usually identical with the *composition plane*. Cf. *twinning axis*.

**two-cycle valley** A valley that is the result of two cycles of erosion, as shown by a narrow inner valley bordered by high-level terraces.

**two-layer structure** A type of crystal structure having two layers to the full repeat unit, e.g. kaolinite, which has one octahedral and one tetrahedral layer per unit along the *c* axis. Cf. *three-layer structure*.

**Tyler standard grade scale** A *grade scale* for the particle-size classification of sediments and soils. It is based on the square root of 2, with the midpoint values of each size class being simple whole numbers or common fractions. It is used as specifications for sieve mesh.

**type** 1. In taxonomy, the standard reference for determining the application of a scientific name. Unless otherwise stated, a type usually refers to the *holotype* of a species. 2. A classification of coal based on the constituent plant

materials. Cf *rank*, *grade*.

**type concept** A principle for stabilizing the application of scientific nomenclature by recognizing a permanent association of a taxon with one of its constituent elements, designated as its nomenclatural *type*, which serves as a point of reference. The nomenclatural type is that element with which the name is permanently associated.

**type fossil** A term occasionally used as a syn of *index fossil*.

**type genus** The genus that serves as a permanent nomenclatural reference for application of the name of a *family*, and the ranks of super- and sub-taxa that have the same common point of nomenclatural reference.

**type locality** 1 The place at which a *stratotype* is situated and from which it ordinarily derives its name. It contains the type section, and is contained within the type area. Cf *reference locality*. 2 The place where a geologic feature (such as an ore occurrence, a particular kind of igneous rock, or the type specimen of a fossil species or subspecies) was first recognized and described.

**type material** All the specimens on which the description of a new species is based.

**type section** 1. The originally described sequence of strata that constitute a stratigraphic unit. It serves as an objective standard with which spatially separated parts of the unit may be compared, and it is preferably in an area where the unit shows maximum thickness and is completely exposed (or at least shows top and bottom). Type sections for litho-stratigraphic units cannot be changed. Cf *reference section*. 2 A syn of *stratotype*, thus constituting not only the type representative of a stratigraphic unit but also that of a stratigraphic boundary or horizon.

**type species** That species on which the original description of a genus or subgenus is largely or entirely based, the *type* of a genus or subgenus. Syn *genotype*.

**type specimen** The single specimen on which the original description of a particular species is based, which serves as a permanent point of nomenclatural reference for application of the name of that species. The type specimen may be a *holotype*, a *neotype*, or a *lectotype*.

**tyuyamunite** (tyu-ya'-mu-nite) An orthorhombic mineral,  $\text{Ca}(\text{UO}_2)_2(\text{VO}_4)_2 \cdot 5-8\text{H}_2\text{O}$ . It is an ore of uranium, and occurs in yellow incrustations as a secondary mineral.

# U

**Udden grade scale** A logarithmic *grade scale* that uses 1 mm as the reference point and progresses by the fixed ratio of 1:2 in the direction of decreasing size and of 2 in the direction of increasing size (that is, 1:25, 0.5, 1:2, 4). See also *Bentworth grade scale*.

**Uintahite** (u-in' tih-ite) *Gilsonite* that occurs primarily in veins in the Uinta Basin, Utah.

**uloxite** (u-l' ox-ite) A white clinomorph  $\text{NaCaB}_4\text{O}_8 \cdot 8\text{H}_2\text{O}$ . It forms reniform masses of extremely fine acicular crystals and is usually associated with barax in saline crusts in and regions. See *ultramarine*.

**Usterian** (U'ste'-ri-an) Lower Devonian of North America.

**ultimate analysis** (ul' ti-mate) The determination of the elements in a compound. For coal, the determination of carbon, hydrogen, sulfur, nitrogen, ash, and oxygen (by *proximate analysis*).

**ultimate base level** The lowest possible *base level* for a stream is sea level, projected inland as an imaginary surface beneath the stream. Cf. *temporary base level*.

**ultimate landform** The theoretical landform produced near the end of a cycle of erosion.

**ultimate recovery** The quantity of oil or gas that a well, pool, field, or property will produce. It is the total obtained or to be obtained from the beginning to final abandonment.

**ultimate strength** The maximum differential stress that a material can sustain under the conditions of deformation. Beyond this point rock failure occurs.

**ultrabasic** (ul'-tra-ba-sic) Said of an igneous rock having a silica content lower than that of a basic rock (i.e., less than about 45%).

Ultrabasic is one subdivision of a widely used system for classifying igneous rocks on the basis of silica content; the other subdivisions are *acidic*, *basic*, and *intermediate*. Cf. *silicic ultramafic*.

**ultramafic** (ul'-tra-maf-ic) Said of an igneous rock composed chiefly of mafic minerals (e.g., monomineralic rocks composed of hypersthene, augite, or olivine). Cf. *ultraparagneiss*.

**ultrametamorphism** (ul'-tra-met'-a-mor'-ph-izm) Metamorphic processes at the extreme upper range of temperature and pressures at which partial to complete fusion of the affected rocks takes place and magma is produced.

**ultrasima** (ul'-tra-si'-na) The supposedly ultrabasic layer of the earth below the sima, immediately beneath the Mohorovičić discontinuity.

**ultraviolet** (ul'-tra-vi-o-let) Pertaining to or designating that part of the electromagnetic spectrum ranging in wavelength from 40 to 4000 angstrom units, mainly in the 3000 to 4000 range.

**umber** A naturally occurring brown earth that is darker than ochre and sienna and that consists of manganese oxides as well as hy-

drated ferric oxide, silica, alumina, and lime. It is highly valued as a permanent paint pigment, and is used either in the greenish-brown natural state ("raw umber") or in the dark-brown or reddish-brown calcined state ("burnt umber").

**umbo** The "humped", or elevated and convex, part of a valve of a bivalve mollusk or of a brachiopod; also a prominence or round elevated structure on the shell or skeleton of several other invertebrates.

**unaka** (u-na'ka) A large residual mass rising above a peneplain and sometimes displaying on its surface the remnants of a peneplain older than the one above which it rises; an erosion remnant of greater size and height than a *monadnock*. Locality: Unaka Mountains of eastern Tennessee and western North Carolina. See also *Catoctin*.

**unakite** (u'-na-kite) An epidote-rich granite, which besides epidote contains pink orthoclase, quartz, and minor opaque oxides, apatite, and zircon. The name is derived from the type locality, the Unaka Range, Great Smoky Mountains, eastern Tennessee.

**unbalanced force** (un-bal'-anced) A force that is not opposed by another force acting along the same line in the opposite direction. An unbalanced force causes translation of a body.

**unconfined ground water** Ground water that has a free water table, i.e. is not confined under pressure beneath relatively impermeable

rocks. *Ant. confined ground water*. *Syn. phreatic water, nonartesian ground water*.

**unconformable** (un-con-form'-able) Said of strata that do not succeed the underlying rocks in immediate order of age or in parallel position; esp. younger strata that do not have the same dip and strike as the underlying rocks. Also, said of the contact between unconformable rocks. Cf. *conformable*. *Syn. discordant*.

**unconformity** (un-con-form'-i-ti)

1 A break or gap in the geologic record, such as an interruption in the normal sequence of deposition of sedimentary rocks, or a break between eroded metamorphic rocks and younger sedimentary strata. An unconformity is of longer duration than a *diastem*.

2 The structural relationship between two groups of rock that are not in normal succession; also, their surface of contact. Cf. *conformity*. —See also *angular unconformity*, *disconformity*, *nonconformity*.

**unconsolidated material** (un-consol'-i-dat-ed) 1 A sediment that is loosely arranged or unstratified, or whose particles are not cemented together, occurring either at the surface or at depth. 2 Soil material that is in a loosely aggregated form.

**unda** (un'-da) adj. Said of the environment of sedimentation that lies in the zone of wave action. It may be used alone or as a combining form. See also *undaform*, *undathem*. Cf. *clino*, *fondo*. *Ety-*

mol: Latin *unda*, "wave".

**undaform** The subaqueous land form produced by the erosive and constructive action of the waves during the development of the subaqueous profile of equilibrium. It is the site of the *unda* environment of deposition. Cf: *clinoform*; *fondoform*.

**undathem** Rock units formed in the *unda* environment of deposition Cf *clinothem*; *fondothem*.

**undation theory** (un-da'-tion) A theory of mountain building that assumes that long broad anticlines of basement rock, generated by deep-seated magma, rose like huge waves in the crust. The sedimentary cover and sometimes the basement itself slid off to form the folds and faults observed in orogenic belts.

**underclay** A layer of clay lying immediately beneath a coal bed. It represents the old soil in which the plants grew from which the coal was formed, and it commonly contains fossil roots. Some underclays are commercial sources of *fireclay*. Syn: *seat earth*.

**undercooling** *supercooling*.

**underfit stream** A stream that appears too small to have eroded the valley in which it flows. It is a common result of drainage changes effected by capture, by glaciers, or by climatic variations.

**underflow** The movement of ground water through the soil or a subsurface stratum, or under a structure; specif., the water flowing beneath the bed of a stream, in the same direction but much more

slowly, esp. under a dry stream channel in an arid region.

**underground stream** A body of water flowing as a definite current in a distinct channel below the surface of the ground, usually in an area characterized by joints or fissures; legally, such a stream discoverable by men without scientific instruments Application of the term to ordinary aquifers is incorrect. Cf *subterranean stream*.

**underground water** *ground water*.

**underhand stoping** The working of a block of ore from an upper to a lower level

**undersaturated** (un-dér-sat'-u-rat-ed) 1. Said of an igneous rock consisting of *unsaturated minerals*, e.g. feldspathoids and olivine. 2. Said of a rock whose norm contains feldspathoids and olivine, or olivine and hypersthene. Cf: *oversaturated*; *saturated*.

**undersaturated pool** A pool in which all the gas present is dissolved in the oil. Cf: *saturated pool*.

**underthrust** A thrust fault in which the footwall was the active element.

**undertow** The seaward return flow, near the bottom of a sloping beach, of water that was carried onto the shore by waves. Cf: *rip current*.

**undulatory extinction** (un'-du-la-to'-ry) A type of optical *extinction* that occurs successively in adjacent areas, as the microscope's stage is turned. Cf: *parallel extinction*; *inclined extinction*.

Syn *wavy extinction*

**uniaxial** (u-ni-ax'-i-al) Said of a crystal having only one optic axis, e.g. a tetragonal or hexagonal crystal Cf *biaxial*

**unicellular** One-celled refers to an organism the entire body of which consists of a single cell

**uniformitarianism** (u-ni-form'-i-tar'-i-an-izm) The fundamental principle that geological processes and natural laws now operating to modify the earth's crust have acted in much the same manner and with essentially the same intensity throughout geologic time and that past geologic events can be explained by forces observable today the classical concept that 'the present is the key to the past' The doctrine does not imply that all change is at a uniform rate and does not exclude minor local catastrophes Cf *catastrophism*

**uniformity coefficient** (u-ni-form'-i-ty) An expression of variety in size of grains that constitute a granular material

**unilocular** (u-ni-lo-cu-lar) Containing a single chamber or cavity, e.g. said of a single chambered foraminifer

**uniserial** (u-ni-se'-ri-al) Consisting of a single row or series e.g. the plates of a primitive ctenoid fish

**unit cell** The smallest volume of parallelepiped within the three-dimensional repetitive pattern of a crystal that contains a complete sample of the atomic or molecular groups that compose this pattern crystal structure can be described

in terms of the translatory repetition of this unit in space in accordance with one of the space lattices

**unit form** A crystal form in a system other than the cubic, having intercepts on the chosen crystal axis that define the axial ratio Unit forms have Miller indices {111}, {110}, {011}, {101}

**unitization** (ni'-nit-i-za'-tion) Consolidation of the management of an entire oil or gas pool, regardless of property lines and lease boundaries in the interest of efficient operation and maximum recovery Production is allocated among individual leases on the basis of a formula

**unit value** The monetary value of a mineral or rock product per ton or other unit of measurement

**univalve** (u-ni-valve) adj Having or consisting of one valve only Cf *bivalve* - n A univalve animal specif a mollusk such as a gastropod or cephalopod

**universal stage** (u-ni-ver'-sal) An apparatus attached to the rotating stage of a polarizing microscope, which enables the thin section under study to be tilted about two horizontal axes at right angles It is used for optical study of low-symmetry minerals or for determining the orientation of any mineral relative to the section surface and edge directions

**unmixing exsolution**

**unpaired terrace** A stream terrace with no corresponding terrace on the opposite side of the valley usually produced by a meander-

ing stream swinging back and forth across a valley Cf: *paired terrace*.

**unsaturated** (un-sat'-u-rat-ed) Said of a mineral that does not form in the presence of free silica; e.g. nepheline, leucite, olivine, feldspaths. Cf: *undersaturated*; *saturated*, *oversaturated*.

**unstable** (un-sta'-ble) 1. Said of a constituent of a sedimentary rock that does not effectively resist further mineralogic change and represents a product of rapid erosion and deposition, e.g. feldspar, pyroxene, various fine-grained rock fragments. 2. Said of an immature sedimentary rock, such as graywacke, that consists of angular, poorly sorted particles of feldspar and rock fragments. 3. Said of a part of the earth's crust that has shown marked uplift, subsidence, or lateral deformation. 4. Said of a radioactive substance.—Cf: *stable*.

**unstable equilibrium** A state of equilibrium from which a chemical system, or a body (such as a pendulum), will depart in response to the slightest perturbation.

**unstratified** (un-strat'-i-fied) Not formed or deposited in strata; specifically said of massive rocks or sediments with an absence of layering, such as granite or glacial till.

**up-dip block** The rocks on the up-thrown side of a fault. Cf: *down-dip block*.

**uphole shooting** In seismic exploration, the setting-off of successive shots in a shothole at

varying depths in order to determine velocities and velocity variation of the materials forming the walls of the hole.

**uphole time** In seismic exploration, the time required for the seismic impulse to travel from a given depth in a shothole to the surface.

**upland** 1. A general term for an extensive region of high ground, esp. far from the coast or in the interior of a country. 2. The high ground of a region, in contrast with its valleys and plains.—Ant: *lowland*.

**uplift** A structurally high area in the crust, produced by movements that raise the rocks, as in a broad dome or arch.

**upper** Pertaining to strata that are normally above those of earlier formations of the same subdivision of rocks. The adjective is applied to the name of a system, series, or stage, to indicate position in the geologic column, and corresponds to *late* as applied to the name of the equivalent geologic-time unit, e.g. rocks of the Upper Jurassic System were formed during the Late Jurassic Period. The initial letter is capitalized to indicate a formal subdivision (e.g. "Upper Devonian") and is lower-cased to indicate an informal subdivision (e.g. "upper Miocene"). Cf: *lower*; *middle*.

**Upper Carboniferous** In European usage, the approximate equivalent of the *Pennsylvanian*. Cf: *Lower Carboniferous*.

**upper mantle** That part of the mantle which lies above a depth

of about 1000 km and has a density of  $3.40 \text{ g/cm}^3$ , in which *P*-wave velocity increases from about 8 to 11 km/sec with depth and *S*-wave velocity increases from about 4.5 to 6 km/sec with depth. It is presumed to be peridotitic in composition. It is sometimes referred to as the *asthenosphere*, and includes the *transition zone*; it is equivalent to the B and C layers.

**upright fold** A fold having an essentially vertical axial surface.

**uprush** The advance of water up the foreshore of a beach or structure, following the breaking of a wave. Cf. *backwash*. Syn. *swash*.

**upthrow** 1. The upthrown side of a fault. 2. The amount of upward vertical displacement of a fault.

Cf. *downtthrow*, *heave*.

**upthrown** Said of that side of a fault that appears to have moved upward, compared with the other side. Cf. *downtthrown*.

**upwarping** The uplift of a region, usually as a result of the release of isostatic pressure, e.g. by the melting of an ice sheet. Cf. *downtwarping*.

**upwelling** 1. The rising of cold, heavy subsurface seawater toward the surface, esp. along the western coasts of continents, the displaced surface water is transported away from the coast by winds or diverging currents. Ant. *sinking*. 2. The relatively quiet eruption of lava and volcanic gases, with little force.

**uralite** (u'-ral-ite) A fibrous or acicular variety of hornblende,

occurring in altered rocks and pseudomorphous after pyroxene *uralitization* (u'-ral'-it-i-za'-tion).

The conversion of pyroxene into hornblende, usually as a finely fibrous aggregate. It is considered to be a late-magmatic process.

**uraninite** (u'-ran'-i-nite) An isometric metallic mineral, essentially  $\text{UO}_2$ . It is strongly radioactive, and is the chief ore of uranium. Uraninite often contains thorium, radium, the cerium and yttrium metals, and lead; when heated, it yields helium. It occurs in veins with the minerals of lead, tin, and copper, and in sandstone deposits, and is a primary constituent of granites and pegmatites. See also *pitchblende*.

**uranium-thorium-lead age method** (u'-ra-ni-um-tho'-ri-um-lead') Calculation of an age in years for geologic material, often zircon, based on the known radioactive decay rate of uranium-238 to lead-206, uranium-235 to lead-207, and thorium-232 to lead-208, whose ratios give three independent ages for the same sample. The method is most applicable to minerals that are Precambrian in age.

**uranophane** (u'-ran'-o-phane) A strongly radioactive yellow orthorhombic secondary mineral,  $\text{Ca}(\text{UO}_2)_2\text{Si}_2\text{O}_7 \cdot 6\text{H}_2\text{O}$ .

**urban geology** (ur'-ban) The application of geologic knowledge and principles to the planning and management of cities and their surroundings. It includes geologic studies for physical planning, waste disposal, land use, water-



resources management, and extraction of usable raw materials

See also *environmental geology*

**U-shaped valley** A valley having a pronounced parabolic cross profile suggesting the form of a widened letter "U", with steep walls and a broad floor. Specific a valley carved by glacial erosion, such as a *glacial trough*. Cf. *V-shaped valley*

*ley*

**uvala** (u va'-la) A syn. of *karst valley*. Etymol. Serbo-Croatian

**uvarovite** (u-vä'-rov-ite) The calcium-chromium end-member of the garnet group, characterized by an emerald-green color.  $\text{Ca}_3\text{Cr}_2(\text{SiO}_4)_3$ . It may have considerable alumina

## V

**vadose water** (va'-dose) Water of the zone of aeration. Syn *suspended water*

**vadose-water discharge** The release, by evaporation, of water not originating in the zone of saturation

**vagrant benthos** (va' grant) Bottom-dwelling organisms that are capable of movement on in or above the substratum

**valid name** (va'-id) A name that must, under the rules of zoological nomenclature, be adopted for a taxon of a particular rank, position, and description

**valley** Any hollow or low-lying land bounded by higher ground, usually traversed by a stream or river which receives the drainage of the surrounding heights. Etymol. Latin *vallis*

**valley fill** The unconsolidated sediment deposited by any agent so as to fill or partly fill a valley

**valley flat** 1 The low flat land lying between valley walls and bordering a stream channel. Syn *flat* 2 A bedrock surface produced by lateral erosion, commonly veneered with the alluvium of a *flood plain*

**valley glacier** *alpine glacier*

**valley plug** A local constriction in a stream channel, formed by any of several types of channel obstructions, which may cause rapid deposition

**valley profile** The longitudinal profile of a valley

**valley sink** *karst valley*

**valley system** A valley and its tributaries

**valley train** A long, narrow body of outwash, deposited by meltwater streams far beyond the terminal moraine or the margin of an active glacier and confined within the walls of a valley below the glacier, it may or may not emerge from the mouth of the valley to join an *outwash plain*

**value** (val'-ue) In economic geology, (a) the valuable constituents of an ore (b) their percentage in an orebody or *assay grade*, (c) their quantity in an orebody, or *assay value*. See also *unit value*

**valve** 1 One of the distinct and usually articulated pieces that make up the shell of certain invertebrates, e.g. one of the two curved calcareous plates that constitute the shell of a bivalve mollusk 2 One of the two silicified pieces forming the top or bottom surface of a diatom *tristula*

**vanadate** (van'-a date) A mineral compound characterized by pentavalent vanadium and oxygen in the anion. An example is vanadinite  $\text{Cl urverite phosphate}$

**vanadinite** (va'nai'-i-nite) A mineral of the apatite group,  $\text{Pb}_5(\text{VO}_4)_3\text{Cl}$ . It often forms globular masses encrusting other minerals in lead mines, and is an ore of vanadium and lead

**van't Hoff's law** The law that when a system is in equilibrium of the two opposed interactions the endothermic is promoted by raising the temperature the exothermic

by lowering it

**variation diagram** (var-i-a'-tion) A binary or ternary diagram that shows the relations among various chemical parameters (e.g. oxide percentages, Niggli numbers, differentiation indexes) of the igneous rocks in a suite. It is designed to reveal genetic relationships and the nature of the processes that have affected the series. See also *Harker diagram*.

**varietal mineral** (va-ri'-e-tal) A mineral that is either present in considerable amounts in a rock or characteristic of the rock, a mineral which distinguishes one variety of rock from another.

**variety** (va-ri'-e-ty) 1. In gemology, a type of a mineral species distinguished by color or other characteristic, e.g. emerald and aquamarine are varieties of beryl. 2. A category in the hierarchy of botanical classification subordinate in rank to *subspecies*.

**variometer** (var-i-om'-e-ter) A device for measuring or recording variations in terrestrial magnetism using the torque on a permanent magnet in a uniform magnetic field.

**Variscan orogeny** (Var-is'-can)  *Hercynian orogeny*.

**varve** 1. A sedimentary lamina or sequence of laminae deposited in a body of still water within one year's time; specifically a pair of layers seasonally deposited in a glacial lake. A glacial varve normally includes a lower 'summer' layer consisting of light-colored sand and silt which grades upward into

a thinner 'winter' layer, consisting of clayey, often organic, dark sediment. Counting and correlation of varves have been used to measure the ages of Pleistocene glacial deposits. 2. Any cyclic sedimentary couplet as in certain shales and evaporites. —Etymol. Swedish *varv* 'layer' or 'periodical iteration of layers'.

**varved clay** A distinctly laminated lacustrine sediment consisting of clay rich varves, also the upper, fine grained, 'winter' layer of a glacial varve.

**vascular plant** (vas'-cu-lar) A plant with a well-developed circulatory system and structural differentiation into roots, stem, and leaves. The majority of terrestrial plants are vascular.

**vaughanite** (vaughan'-ite) A pure light gray fine textured limestone that breaks with a smooth and more or less pronounced conchoidal fracture, contains relatively few fossils and typically has a white chalky appearance on weathered surfaces.

**vegetation polygon** (veg-e-ta'-tion) A small *nonsorted polygon* whose fissured borders are emphasized by thick vegetation (usually moss, lichen, or willow) and whose center consists of fine-textured material or a mixture of fines and stones. Diameter about 1 m.

**vein** An epigenetic mineral filling of a fault or other fracture in tabular or sheetlike form, often with associated replacement of the host rock, a mineral deposit of this form and origin. Cf. *lode*.

**vein dike** A pegmatitic intrusion that has the characteristics of both a vein and a dike.

**veined gneiss** A composite gneiss with irregular layering. The term is generally used in the field and has no genetic implications.

**vein quartz** A rock composed chiefly of sutured quartz crystals of pegmatitic or hydrothermal origin and commonly of variable size.

**velocity analysis** (ve-loc'-i-ty) Calculation of velocity distribution of seismic signals using normal-moveout times at large geophone—shot point distances. Cf: *normal-moveout velocity*.

**velocity coefficient** A numerical factor, always less than unity, that expresses the ratio between the velocity of water issuing from an orifice or other hydraulic structure and the theoretical velocity that would exist if there were no friction loss. The square of the velocity coefficient is a measure of the efficiency of a structure as a waterway.

**velocity discontinuity** An abrupt change of the rate of propagation of seismic waves within the earth, as at a seismic *discontinuity*.

**velocity log** *sonic log*.

**velocity profile** A seismic arrangement used to record reflections over a large range of shot-to-geophone distances, which is used to determine seismic velocity from the time-distance relationship.

**vent** The opening at the earth's surface through which volcanic materials are extruded; also, the

channel or conduit through which they pass. Cf: *neck*.

**vent breccia** Volcanic breccia that is localized within a vent; a filling or neck of breccia.

**ventifact** (ven'-ti-fact) A general term for any stone or pebble shaped, worn, faceted, cut, or polished by the abrasive or sandblast action of windblown sand, generally under desert conditions; e.g. a *dreikanter*. See also: *windkanter*.

**ventral** (ven'-tral) 1. Pertaining or belonging to the abdominal or lower surface of an animal or of one of its parts that is opposite the back. 2. Referring to the direction or side of an echinoderm toward or containing the mouth, normally upward; adoral or oral.—Ant: *dorsal*.

**Venus hair** Needlelike crystals of reddish-brown or yellow rutile, forming tangled swarms of inclusions in quartz. See also: *sagenite*.

**verd antique** A dark green massive serpentine, commonly with veinlets of calcium carbonate and magnesium carbonate. It is capable of being polished and is commercially considered a marble. Also spelled: *verde antique*. Syn: *green marble*; *serpentine marble*.

**vermiculite** (ver-mic'-u-lite) A group of micaceous clay minerals closely related to chlorite and montmorillonite and having the general formula  $(\text{Mg}, \text{Fe}, \text{Al})_3(\text{Al}, \text{Si})_4\text{O}_{10}(\text{OH})_2 \cdot 4\text{H}_2\text{O}$ . Vermiculite is derived from the alteration of biotite and phlogopite in the zone of weathering. Grains undergo

marked exfoliation when heated at 800° to 1100°C, producing wormlike particles that entrap air and are used as an insulator and lightweight aggregate.

**Vertebrata** (Ver-te-bra'-ta) A subphylum of the Chordata characterized by an internal skeleton of cartilage or bone, and by specialized organization of the anterior end of the animal, the front of the body is a head that bears organs of sight, smell, taste, and hearing, and the front of the central nervous system is a brain.

**vertebrate paleontology** (ver'-te-brate) The branch of paleontology dealing with fossil vertebrates.

**vertical accretion** (ver'-ti-cal) Upward growth of a sedimentary deposit, e.g. settling of sediment from suspension in a stream subject to overflow. Cf. *lateral accretion*.

**vertical exaggeration** 1 The extent to which the vertical scale is larger than the horizontal scale on a cross section or stereonet model. It should be stated in the legend. 2 In a stereoscopic image, the increased relief seen by the eye.

**vertical intensity** The magnitude of the vertical component of any vector, e.g. of the earth's magnetic or gravitational field at any point.

**vertical photograph** An aerial photograph made with the camera axis vertical or as nearly vertical as practicable. Cf. *oblique*.

**vertical section** 1 A natural or artificial vertical exposure of rocks or soil, as in a sea cliff or canyon wall. 2 A diagram representing a

vertical segment of the earth's crust either exposed or as it would appear if cut through by any intersecting vertical plane, e.g. a *columnar section* or a *structure section*.

**vertical separation** In a fault, the distance measured vertically between two parts of a displaced marker such as a bed. Cf. *horizontal separation*.

**vertical shift** In a fault, the vertical component of the shift.

**vertical slip** In faulting, the vertical component of the net slip, it equals the vertical component of the dip slip. Cf. *horizontal slip*. Syn. *vertical dip slip*.

**vertical-variability map** (ver'-ti-cal var'-i-a-bil'-i-ty) A stratigraphic map that depicts the relative vertical positions, thicknesses, and number of occurrences of specific rock types in a sequence of strata, e.g. a "number-of-sandstones map" or a "limestone mean-thickness map". Cf. *facies map*, *multipartite map*.

**very angular** Having very sharp angles or edges, specif. said of freshly broken, unabraded sedimentary particles. Also, said of the *roundness class* containing very angular particles.

**very coarse sand** Sand with particle diameters between 1 and 2 mm.

**very fine sand** Sand with particle diameters in the range of 0.062 to 0.125 mm.

**very thick bands** In banded coal, vitrain bands exceeding 50.0 mm in thickness. Cf. *thin bands*, *medi-*

*um bands, thick bands*

**vesicle** (ves'-i-cle) A small cavity in an aphanitic or glassy igneous rock, formed by the expansion of a bubble of gas or steam during the solidification of the rock

**vesicular** (ve-sic'-u-lar) Characterized by or containing vesicles. Cf. *cellular*

**vestigial structure** (ves-tig'-i-al) A small and degenerate or imperfectly developed bodily part or organ that is a remnant of one more fully developed in an earlier stage in the life cycle of the individual, in a past generation, or in closely related forms. Vestigial structures are nonfunctional, with succeeding generations they may die out entirely

**vesuvianite** (ve-su -vi-an-ite) A mineral  $(\text{Ca}_{10}\text{Mg}_2\text{Al}_4(\text{SiO}_4)_3(\text{Si}_2\text{O}_7)(\text{OH})_4$ . It sometimes contains iron and fluorine, and is commonly found in contact-metamorphosed limestones. Syn. *idocrase*

**vibration gravimeter** (vi bra'-tion) A device that affords a measurement of gravity by observation of the period of transverse vibration of a thin wire tensioned by the weight of a known mass. It is useful for observations at sea

**vicinal face** (vic'-i-nal) A crystal face that modifies a normal crystal face, which it closely approximates in angle

**virgation** (vir-ga'-tion) 1. A sheaf-like pattern, as shown on a map of mountain ranges diverging from a common center. Cf. *synaxis*. 2. A fold pattern in which the axial surfaces diverge or fan

out from a central bundle

**Virgilian** (Vir-gil'-i-an) Uppermost

Pennsylvanian of North America

**viscosity** (vis-cos-i-ty) The property of a substance to offer internal resistance to flow. Its internal friction. See *viscosity coefficient*

**viscosity coefficient** A numerical factor that measures the internal resistance of a fluid to flow. It equals the shearing force in dynes/sq. cm transmitted from one fluid plane to another that is 1 cm away, and generated by the difference in fluid velocities of 1 cm/sec in the two planes. The greater the resistance to flow, the larger the coefficient

**viscous flow** (vis'-cous) In experimental structural geology, flow in which the rate of shear strain is directly proportional to the shear stress. Cf. *liquid flow, solid flow*

**vitrain** (vit'-rain) An ingredient of banded coal characterized by brilliant, vitreous luster, black color, and cubic cleavage with conchoidal fracture. Vitrain bands or lenticles are amorphous, and thick enough to be visible to the unaided eye. Cf. *clarain, durain, fusain*

**vitreous** (vit'-re-ous) Having the luster and appearance of glass

**vitric tuff** (vit'-ric) An indurated deposit of volcanic ash composed chiefly of fragments of glass blown out during an eruption

**vitrification** (vit-ri-fac'-tion) *vitrification*

**vitrification** (vit-ri-fi-ca'-tion) Formation of a glass. Syn. *vitrification*

**vitrify** (vit-ri-fy) To convert into

glass or a glassy substance by fusion

**vitrinization** (vit'-ri-ni-za'-tion) A process of coalification in which certain *1* formed (cf *incorporation, fusion, zation*)

**vitroclastic** (vit-rok-las'-tik) Pertaining to a pyroclastic rock structure characterized by fragmented bits of glass, also, said of a rock having such a structure

**vitrophyre** (vit'-to-phyre) Any porphyritic igneous rock having a glassy groundmass. Adj. *vitrophyric*

**vitrophyric** (vit-to-phyr-ik) Of or pertaining to vitrophyre

**void interspace**

**voidal concretion** Hollow amount to concretion resulting from the weathering of clay ironstone

**void ratio** The ratio of the volume of void space to that of solid material in a sediment or sedimentary rock

**volatile component** (vol-a-tile) *fugitive constituent*

**volatile matter** In coal, those substances, other than moisture, that are given off as gas and vapor during combustion. Standardized laboratory methods are used in analysis. Syn. *volatiles*

**volatiles** *1* volatile matter. *2* fugitive constituents.

**volcanic** (vol-can'-ik) *1* Pertaining to the activities, structures, or rock types of a volcano. *2* A syn of *extrusive*

**volcanic ash** Fine pyroclastic matter (under 2 mm in diameter). The term usually refers to unconsolidated material, but is some-

times also used for its consolidated counterpart, or *tuff*. Syn. *ash dust, pumice*

**volcanic belt volcanic chain**

**volcanic bomb** A blob of lava that was ejected while viscous and received a rounded shape while in flight. It is larger than 64 mm in diameter, and may be vesicular to hollow. Actual shape or form varies greatly. Syn. *bomb*

**volcanic breccia** *1* A pyroclastic rock that consists of angular volcanic fragments that are larger than 64 mm in diameter and that may or may not have a matrix. Cf. *agglomera*. *2* A rock composed of non-volcanic fragments in a volcanic matrix

**volcanic chain** Linear arrangement of a number of volcanoes, apparently associated with a major tectonic feature, such as a fault or subduction zone

**volcanic cloud eruption cloud**

**volcanic cluster** A group of volcanic vents with no apparent systematic arrangement

**volcanic conduit** The channelway that brings volcanic material up from depth. Cf. *vent*

**volcanic cone** A conical hill of lava and/or pyroclastics that is built up around a volcanic vent. Syn. *cone*

**volcanic conglomerate** A water-deposited conglomerate containing over 50% volcanic material, esp. coarse pyroclastics

**volcanic dome** A steep-sided protrusion of viscous lava squeezed out from a volcano, forming a dome-shaped or bulbous mass

above and around the vent. Older lavas may be lifted by the pressure of new lava rising from below. The structure generally develops inside a volcanic crater or on the flank of a large volcano, and is usually much fissured and brecciated. Cf. *lava dome*, *plug dome*. Syn: *dome*, *cumulo dome*.

**volcanic earthquake** A seismic disturbance whose origin lies under or near a volcano, whether active, dormant, or extinct.

**volcanic ejecta** *tephra*.

**volcanic focus** The supposed seat or center of activity in a volcanic region or beneath a volcano.

**volcanic gases** Volatile matter, released during a volcanic eruption, that was previously dissolved in the magma. Water vapor forms about 90% of the gases; other constituents include carbon dioxide, sulfur dioxide at high temperatures and hydrogen sulfide at low temperatures, hydrogen chloride, and nitrogen as a free element.

**volcanic glass** Natural glass produced by the cooling of molten lava, or some liquid fraction of it, too rapidly to permit crystallization. Examples are obsidian, pitchstone, tachylite, and the glassy groundmass of many extrusive rocks.

**volcanicity** (vol-ca-nic'-i-ty) *volcanism*.

**volcaniclastic** (vol-ca'-ni-clas'-tic) Pertaining to a clastic rock containing volcanic material in whatever proportion, and without regard to its origin or environment.

**volcanic mud** Mud formed by the mixture of water with volcanic ash, often initially hot and flowing down the flanks of a volcanic cone as a *mudflow*.

**volcanic neck** A vertical pipe-like intrusion that represents a former volcanic vent, esp. if standing as an erosional remnant. Syn: *neck*.

**volcanic rent** A great volcanic depression, bordered by fissures that are usually concentric in plan, caused by magmatic activity or by the overloading of cone material on a weak substratum.

**volcanic rock** 1. A finely crystalline or glassy igneous rock resulting from volcanic action at or near the earth's surface, either ejected explosively or extruded as lava, e.g. basalt. The term includes near-surface intrusions that form a part of the volcanic structure. 2. A general term to include the effusive rocks and associated high-level intrusive rocks; they are dominantly basic.

**volcanic sand** Sand-sized volcanic debris of either pyroclastic or detrital origin.

**volcanic spine** A slender, pointed monolithic protrusion of viscous lava squeezed up on the surface of a thick lava flow or volcanic dome through an opening in the solidified crust. They range in height from a few inches to many hundreds of feet. The classic example of a large spine is the one that formed on Mt. Pelée, in Martinique. Syn: *spine*.

**volcanic water** Water in or derived from magma at the earth's surface.



or at a relatively shallow depth; *juvenile* water of volcanic origin.

**volcanism** (vol'-can-izm) The processes by which magma and its associated gases rise into the crust and are extruded onto the earth's surface and into the atmosphere. Also spelled *vulcanism*. Syn: *volcanicity*.

**volcano** (vol-ca'-no) 1. A vent in the surface of the earth through which magma and associated gases and ash erupt; also, the form or structure, usually conical, that is produced by the ejected material. 2. Any eruption of material, e.g. mud, that resembles a magmatic volcano.—Pl: *volcanoes*. Etymol: the Roman deity of fire, Vulcan.

**volcanogenic** (vol'-ca-no-gen'-ic) Formed by processes directly connected with volcanism; specif. said of mineral deposits (massive sulfides, banded iron formations) considered to have been produced through volcanic agencies and demonstrably associated with volcanic phenomena. Also spelled: *volcanigenic*.

**volcanologist** (vol-ca-nol'-o-gist) One who studies volcanology.

**volcanology** (vol-ca-nol'-o-gy) The branch of geology that deals with volcanism, its causes and phenomena.

**volume elasticity** *bulk modulus*.

**volume law** (vol'-ume) *Lindgren's volume law*.

**von Wolff's classification** A quan-

titative chemical-mineralogical classification of igneous rocks.

**V-shaped valley** A valley having a cross profile suggesting the form of the letter "V", characterized by steep sides and short tributaries; specif. a young, narrow valley resulting from downcutting by a stream. The "V" becomes broader as the amount of mass wasting increases. Cf: *U-shaped valley*.

**vug** A small cavity in a vein or in rock, usually lined with crystals of a different mineral composition from the enclosing rock. Etymol: Cornish *wooga*, "underground chamber, cavity" Adj: *vuggy*. Cf: *druse*; *geode*.

**vuggy porosity** In petroleum geology, porosity resulting from the presence of openings ("vugs") from the size of a small pea upwards; it is usually used with reference to limestones.

**Vulcanian-type eruption** (Vul-ca'-ni-an-type) A type of volcanic eruption characterized by the explosive ejection of fragments of new lava, commonly incandescent when they leave the vent but either solid or too viscous to assume any appreciable degree of rounding during their flight through the air. With these there are often *breadcrust bombs* or *blocks*, and generally large proportions of ash.

**vulcanism** (vul'-can-izm) *volcanism*.

## W

**wacke** (wack'-e) 1 A "dirty" sandstone that consists of a mixture of poorly sorted mineral and rock fragments in an abundant matrix of clay and fine silt, specif an impure sandstone containing more than 10% argillaceous matrix. The term is used for a major category of sandstone, as distinguished from *arenite* 2 A clastic sedimentary rock in which the grains are almost evenly distributed among the several size grades, e.g. a sandstone consisting of sediment "poured in" to a basin of deposition at a comparatively rapid rate without much selection or reworking 3 A shortened form of *graywacke* This usage is not recommended Etymol German

**wad** A dark brown or black impure mixture of manganese and other oxides It contains 10 to 20% water, and is generally soft, soiling the hand Syn *bog manganese*

**walled lake** A lake bordered along its shore by *lake ramparts*

**wall rock** The rock forming the walls of a vein, lode, or igneous intrusion Cf *country rock*

**warm glacier** *temperate glacier*

**warping** A slight bending or flexing of the earth's crust on a regional scale, *upwarping* or *downwarping*

**wash** 1 A piece of land, e.g. an area of sandbanks or mudbanks, that is alternately submerged and

exposed by the tide; also, the shallowest part of an estuary. 2. *rain-wash* 3. Coarse alluvium, as in an *alluvial fan*. 4. A term used esp. in the southwestern U.S. for the broad, gravelly dry bed of an intermittent stream, generally in the bottom of a canyon; it is occasionally swept by a torrent of water. 5. An alluvial placer. 6. Detritus partly or completely filling a cave. *wash load* *suspended load*

**washout** 1 The washing-away of earth materials as a result of flood or downpour, also, a place where such an event has occurred. 2 A *cutout* in a coal seam. 3 A channel produced in a sedimentary deposit by the scouring action of flowing water and later filled with sediment Cf *scour and fill*

**washover** (wash'-o-ver) 1. Small deltas built on the landward side of a bar or barrier, produced by storm waves breaking over low places and depositing sediment in the lagoon. 2 The process by which a washover is formed.

**wastage** (wast'-age) 1 *ablation*. 2 A general term for denudation of the earth's surface

**waste** Loose material resulting from weathering by mechanical and chemical means, and moved down sloping surfaces or carried short distances by streams to the sea, esp *debris*

**waste rock** In mining, rock that must be broken and disposed of in order to gain access to and excavate the ore; valueless rock that must be removed or set aside in mining. Syn *muck*

**water content** Water contained in porous sediment or sedimentary rock, generally expressed as a ratio of water weight to dry sediment weight. See also: *moisture content*.

**watercourse** A natural, well-defined channel produced wholly or in part by a definite flow of water, continuous or intermittent. Also, a ditch, canal, aqueduct, or other artificial channel for the conveyance of water, as for the draining of a swamp.

**water cycle** *hydrologic cycle*.

**water drive** Energy within an oil or gas pool, resulting from hydrostatic or hydrodynamic pressure transmitted from the surrounding aquifer. Cf. *dissolved-gas drive*; *gas-cap drive*.

**waterfall** A perpendicular or steep descent of a stream, as where it crosses an outcrop of resistant rock overhanging softer rock that has been eroded, or flows over the edge of a plateau or cliffed coast. See also: *cascade*; *cataract*.

**water flooding** A *secondary recovery* operation in which water is injected into a petroleum reservoir to force additional oil out of the reservoir rock and into producing wells.

**water gap** A deep pass in a mountain ridge, through which a stream flows; esp a narrow gorge or ravine cut through resistant rocks by an antecedent stream. Example. Delaware Water Gap, Penna Cf. *wind gap*.

**waterlime** *hydraulic limestone*.

**water of dehydration** Water that

has been set free from its chemically combined state.

**water of imbibition** 1. The amount of water a rock can contain above the water table. 2. Water of saturation, i.e. the amount of water that can be absorbed by water-bearing material without dilation of the material.

**water of retention** That part of the interstitial water in a sedimentary rock that remains in the pores under capillary pressure and conditions of unhindered flow. It is incorrectly called connate water.

**watershed** 1. A term used in Great Britain for a drainage *divide*. 2. A *drainage basin*. — Etymol: probably German *Wasserscheide*, "water parting" The term is ambiguous, and the uncertainty of meaning entailed by this double usage makes it undesirable.

**water table** The surface between the *zone of saturation* and the *zone of aeration*; that surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere. Syn: *ground-water surface*; *ground-water level*.

**water-table well** A well tapping unconfined ground water. Its water level may, but does not necessarily, lie at the level of the water table Cf. *artesian well*.

**water vein** 1. Ground water in a crevice or fissure in dense rock. 2. A term popularly applied to any body of ground water, in part because dowsers commonly describe water as occurring in veins. The term is little used among hy-

drologists.

**water witch** *dowser*.

**Waucohan** (Wau-co'-ban) Lower Cambrian of North America.

**wave 1.** An oscillatory movement in a body of water manifested by an alternate rise and fall of the surface. 2. A seismic wave.

**wave base** The depth at which wave action no longer stirs the sediments; it is usually about 10 meters.

**wave-built terrace** A gently sloping coastal feature at the seaward or lakeward edge of a wave-cut platform, constructed by sediment brought by rivers or drifted along the shore or across the platform and deposited in the deeper water beyond. See also: *marine-built terrace*; *marine terrace*.

**wave-current ripple mark** A compound ripple mark in which the material forming the crest is believed to have accumulated by the oscillation produced by wave action on a pre-existing transverse (current) ripple mark.

**wave-cut beach** A level to gently sloping narrow surface produced by wave erosion, extending outward from the wave-cut cliff; it is developed mainly above water level by storm waves, weathering, and rainwash. The bench may be bare rock or it may be temporarily covered by a beach. See also: *wave-cut platform*.

**wave-cut cliff** *sea cliff*.

**wave-cut notch** *notch*.

**wave-cut platform** A gently sloping surface produced by wave erosion, extending far into the sea or

lake from the base of the wave-cut cliff. Cf: *marine-cut platform*. Syn: *wave-cut terrace*; *wave platform*.

**wave-cut terrace** A syn. of *wave-cut platform*. The term is inconsistent because a terrace is usually regarded as a constructional feature.

**wave delta washover**.

**wavefront 1.** A surface representing the position of a traveling seismic disturbance at a particular time. 2. In optics, the locus of all the points reached by light that is sent outward in all directions from a point. In an isotropic medium, the wavefront is a sphere.—Also spelled: *wave front*.

**wavefront chart** A diagram showing the position of a traveling seismic disturbance at successive times. It usually shows *raypaths* also.

**wavelength 1.** The distance between successive wave crests, or other equivalent points, in a series of harmonic waves. 2. In symmetrical, periodic fold systems, the distance between adjacent anti-formal or synformal hinges.

**wavemark** *swash mark*.

**wave normal** In optics, the line at a given point perpendicular to a plane that is tangent to the surface of a light wave at that point. Cf: *wavefront*.

**wave of oscillation** *oscillatory wave*.

**wave of translation** A water wave in which the individual particles of water are significantly dis-

placed in the direction of wave travel. Cf: *oscillatory wave*.

**wave platform** *wave-cut platform*.

**wave refraction** The process by which a water wave, moving in shallow water as it approaches the shore at an angle, tends to be turned from its original direction.

The part of the wave advancing in shallower water moves more slowly than the part still advancing in deeper water, causing the wave crests to bend toward parallel alignment with the shoreline.

**wave ripple mark** *oscillation ripple mark*.

**wave steepness** The ratio of a wave's height to its length.

**wave surface** In optics, a syn of *wavefront*.

**wavy extinction** *undulatory extinction*.

**W-chert** Chert nodules formed by weathering. Cf: *I-chert*.

**W-dolostone** Dolostone produced by weathering. Cf: *S-dolostone*; *T-dolostone*.

**weather** (weath'-er) *v.* To undergo changes, such as crumbling or pitting of rock surfaces, brought about by exposure to the atmosphere and its agents. See also: *weathering*.

**weathered layer** (weath'-ered) In seismology, that zone of the earth that is immediately below the surface, characterized by low seismic-wave velocities. Syn: *low-velocity zone*.

**weathering** (weath'-er-ing) The destructive processes by which rocks are changed on exposure to atmospheric agents at or near the

earth's surface, with little or no transport of the loosened or altered material; specif. the physical disintegration and chemical decomposition of rock that produce an in-situ mantle of waste and prepare sediments for transportation.

**weathering correction** In seismic exploration, a correction applied to reflection and refraction data for variations in traveltime produced by irregularities in a low-velocity or weathered layer near the surface. Syn: *low-velocity-layer correction*.

**weathering index** A measure of the weathering characteristics of coal, according to a standard laboratory procedure.

**weathering-potential index** A measure of the degree of susceptibility to weathering of a rock or a mineral, computed from a chemical analysis.

**weathering velocity** That velocity with which a seismic *P* wave travels through the near-surface *low-velocity zone*.

**wedge on.** *thin out*.

**welded tuff** A glass-rich pyroclastic rock that has been indurated by the welding together of its glass shards under the combined action of the heat retained by particles, the weight of overlying material, and hot gases. It is generally composed of silicic pyroclasts and appears banded or streaky. Syn: *tufflava*. See also: *ignimbrite*.

**welding** 1. Consolidation of sediments (esp. of clays) by pressure

resulting from the weight of overlying material or from earth movement, characterized by cohering particles brought within the limits of mutual molecular attraction as water is squeezed out of the sediments. 2 The diagenetic process whereby discrete crystals and/or grains become attached to each other during compaction, often involving pressure solution and solution transfer.

**well cuttings** Rock chips cut by a bit in the process of well drilling, and removed from the hole in the drilling mud in rotary drilling, or by the hauler in cable-tool drilling. Well cuttings collected at closely spaced intervals provide a record of the strata penetrated. Syn: *cuttings*, *well samples*.

**well-graded** 1 A geologic term for *well-sorted*. 2 An engineering term pertaining to a soil or sediment with a continuous distribution of particle sizes from coarsest to finest, in such proportions that the smaller particles almost completely fill the spaces between the larger ones. —Ant: *poorly graded*.

**well log** A graphic record of the measured or computed physical characteristics of the rock section encountered in a well, plotted as a continuous function of depth. Measurements are made by a *sonde* as it is withdrawn from the borehole by a *wire line*. Several measurements are usually made simultaneously and the resulting curves are displayed side by side on the common depth scale. Both the full display and the individual

curves are called *logs*. Well logs are commonly referred to by generic type, e.g. *resistivity log*, or by specific curve type, e.g. *sonic log*. See also *sample log*.

**well-rounded** Said of a sedimentary particle whose original faces, edges, and corners have been destroyed by abrasion and whose entire surface consists of broad curves without any flat areas. The original shape is suggested by the present form of the particle. Also said of the *roundness* class containing well-rounded particles.

**well samples** *well cuttings*.

**well shooting** In seismic prospecting, a method of determining velocity as a function of depth by lowering a geophone into a borehole and recording energy from shots fired from surface shot holes.

**well-sorted** Said of a clastic sediment or rock that consists of particles all having approximately the same size. Ant: *poorly sorted*. See also *well-graded*.

**welt** A raised part of the earth's crust of any size with a distinct linear development. Cf. *furrow*.

**Wentworth grade scale** An extended version of the *Udden grade scale* in which the size limits for the common grade terms are modified but the geometric interval or constant ratio of 1/2 is retained. The scale ranges from clay particles (diameter less than 1/256 mm) to boulders (diameter greater than 256 mm). It is the grade scale generally used by North American sedimentolo-

gists. See also *phi grade scale*.  
**Wernerian** (Wer-ne'-n-an) adj. Of or relating to Abraham G. Werner (1749-1817), German geologist and mineralogist, who classified minerals according to their external characters, advocated the theory of *neptunism*, and postulated a worldwide age sequence of rocks based on their lithology. Also, said of one who is a great, but dogmatic teacher of geology —n. An adherent of Wernerian beliefs, a *neptunist*.  
**wet gas** A natural gas containing liquid hydrocarbons. Cf. *dry gas*, *condensate*.  
**wetted perimeter** The length of the wetted contact between a stream of flowing water and its containing conduit or channel, measured in a plane at right angles to the direction of flow. It is used in computing the *hydraulic radius*.  
**whaleback** 1. A large mound or hill having the general shape of a whale's back, esp. a smooth elongated ridge of desert sand having a rounded crest and ranging widely in size (about 300 km long, 1-3 km wide, and perhaps 50 m high). It forms a coarse-grained platform or pedestal built up and left behind by a succession of longitudinal (seif) dunes along the same path. 2. A rounded, elongated rock mass, commonly granite, found in tropical areas associated with *torii*. 3. A *roche moutonnée* often of granitic composition such as those in Canada and Finland.  
**whetstone** Any hard fine-grained

rock, usually siliceous, that is suitable for sharpening implements such as knives and mechanics' tools, e.g. *novaculite*.  
**whipstock** n. A long wedge-shaped steel device with a concave groove along its inclined face, placed in an oil well and used during drilling to deflect and guide the drill bit toward the direction in which the inclined grooved surface is facing —v. To use a whipstock in *directional drilling*.  
**whirlpool** A body of water moving rapidly in a circular path of relatively limited radius. It may be produced by a current's passage through an irregular channel or by the meeting of two opposing currents. Cf. *eddy*.  
**whistling sand** (whis'-ting) A *sounding sand* often found on a beach that gives rise to a high-pitched note when stepped on or struck with the hand, the sound apparently resulting from the movement of grain over grain. Syn. *musical sand*.  
**white mica** A light-colored mica, specif. *muscovite*.  
**whiting** 1. A mass of muddy water in which abundant carbonate material is suspended producing a white color. Whittings typically occur over shallow carbonate platforms and are elongated by wind or tidal currents. Most of them consist of stirred-up bottom sediment. 2. Finely ground chalk of England and France, used in paint.  
**whole-rock analysis** A procedure in which a portion of rock, rather

than individual minerals, is examined. For certain types of analysis, e.g. in the rubidium-strontium age method, it is the preferred approach.

**whorl** One of the turns of a spiral or coiled shell; specif. a single complete turn through 360 degrees of a gastropod shell, a cephalopod conch, or a foraminiferal test.

**wildcat** *wildcat well*

**wildcat well** An exploratory well drilled for oil or gas on a geological feature not yet proven to be productive, or in an unproven territory, or to a zone that has never produced or is not known to be productive in the general area. Cf. *outpost well*. Syn. *wildcat*.

**wildflysch** A type of *flysch* facies displaying large and irregularly sorted blocks and boulders resulting from tectonic fragmentation, and twisted, contorted, and confused beds resulting from slumping or sliding under the influence of gravity. The term was first applied in the Alps.

**willemitite** (wil'-lem-ite) A rhombohedral mineral,  $Zn_2SiO_4$ . It is a minor ore of zinc and commonly contains manganese.

**wind abrasion** A process of erosion in which windblown particles of rock material scour and wear away exposed surfaces of any kind. Syn. *wind corrosion*.

**wind corrosion** *wind abrasion*

**wind gap** 1. A shallow notch in the crest or upper part of a mountain ridge, usually at a higher level than a water gap. 2. A former wa-

ter gap, now abandoned (as by piracy) by the stream that formed it, a pass that is not occupied by a stream.

**windkanter** (wind'-kan-ter) A ventifact, usually highly polished, bounded by one or more smooth faces or facets intersecting in sharp edges or angles. The faces may be cut at different times, as when the wind changes seasonally, or the pebble is undetermined and turned over on its flattened face. Frymol. German. See also *ein Kanter*, *zweikanter*, *dreikanter*.

**window** (win'-dow) An area of erosion in an overthrust sheet in which the rocks beneath the overthrust are exposed. Syn. *fenster*.

**wind polish** *desert polish*

**wind ripple** 1. One of many wavelike, asymmetrical forms produced on sand by wind. It is generally longer and lower than an aqueous ripple mark, but is similar in having a steep lee side and a gentle windward side. 2. One of a series of wavelike forms on a snow surface, lying at right angles to the wind direction.

**wind shadow** The area in the lee of an obstacle, where air motion is not capable of moving material (such as sand) and thus allows it to accumulate; the zone that is gradually filled with sand drift during the formation of a dune, and determines the shape of the dune. Syn. *shadow zone*.

**windward** adj. Said of the side of an object located toward the direction from which the wind is blowing, facing the wind, such as



the "windward slope" of a dune—n The direction from which the wind is blowing.

**wineglass valley** A valley resembling in plan view a goblet or champagne glass. It flares broadly at its upper end, where it has a cup-shaped or funnel-shaped head, narrows sharply to form a constricted lower section; and flares open again on a spreading alluvial fan. The valley commonly forms at right angles to a fault scarp in an arid region. *Syn* *hour-glass valley*

**winning** Separation of fine particles from coarser ones by action of the wind

**wire line** A general term for any flexible steel line or cable connecting a surface winch to a tool assembly lowered in a well bore

**wire-line test** A procedure for measuring the potential productivity of an oil reservoir by means of a tool lowered into a borehole by a *wire line*, in which a sample of fluid and the formation pressure are obtained. It is faster than a *drill-stem test*.

**Wisconsin** (Wis-con-sin) Pertaining to the classical fourth glacial stage of the Pleistocene Epoch in North America, following the Sangamon interglacial stage and preceding the Holocene. See also *Wurm*

**witherite** (with'-er-ite) A yellowish-white or grayish-white orthorhombic mineral of the aragonite group  $\text{BaCO}_3$

**witness corner** A monumented survey point near a corner and

usually on a line of the survey, established as a reference mark where the true corner is inaccessible or cannot be monumented or occupied; e.g. a post set near the corner of a mining claim, with the distance and direction of the true corner indicated thereon

*wold* *cuesta*

**Wolfcampian** Lowermost Permian of North America

**wolframite** (wolf'-ram-ite) A mineral,  $(\text{Fe,Mn})\text{WO}_4$ . It occurs in monoclinic crystals and in granular masses or columnar aggregates. Wolframite is the principal ore of tungsten

**wollastonite** (wol'-las-ton-ite) A triclinic mineral of the pyroxenoid group,  $\text{CaSiO}_3$ . It is found in contact-metamorphosed limestones, and occurs usually in cleavable masses or sometimes in tabular twinned crystals. It is used in making wall and floor tile.

**wood opal** A variety of common opal that has filled the cavities in, and replaced the organic matter of, wood and that often preserves the original features of the wood. *Syn* *xylopal*

**wood tin** A nodular or reniform brownish variety of cassiterite, having a concentric structure of radiating fibers resembling dry wood in appearance

**Worden gravimeter** A compact temperature-compensated gravimeter, in which a system is held in unstable equilibrium about an axis, so that an increase in the gravitational pull on a mass at the end of a weight arm causes a rota-

tion opposed by a sensitive spring. The meter has a sensitivity of less than 0.1 milligal.

**world rift system** A major tectonic element of the earth, consisting of midoceanic ridges and their associated rift valleys, such as those along the Mid-Atlantic Ridge. It is believed to be the locus of extensional splitting and upwelling of magma that has resulted in *sea-floor spreading* Cf *rift*.

**worm cast** 1 A sinuous fossil trail of a worm, preserved as a sand cast on the bedding plane of an arenaceous rock 2 Excretion of an earthworm

**worm's-eye map** 1 A map showing the pattern of formations that would be visible to an observer looking upward at the bottom of the rocks overlying a given surface, e.g. an unconformity or a surface of onlap Syn *lap-out map* 2 A map showing overlap of sediments, or progressive transgressions of a sea over a given surface

**wrench fault** A more or less vertical fault along which there has been strike separation Syn *torsion fault*

**wrinkle ridge** (wrin'-kle) A sinuous, irregular, segmented, apparently smooth elevation occurring within the borders of a mare region of the moon's surface and characterized by dike-like outcrops, crest-top craters, and lon-

gitudinal rifts. Wrinkle ridges are up to 35 km wide and 100 m high, and may extend for hundreds of kilometers. They probably originated in fissure eruptions or from volcanic activity along fractures Syn: *mare ridge*

**wulfenite** (wul'-fen-ite) A tetragonal mineral,  $PbMoO_4$ . It occurs in tabular crystals and in granular masses, and is an ore mineral of molybdenum.

**Wulff net** A coordinate system used in crystallography to plot a polar stereographic projection with conservation of equal angles, such as for plotting angular relations obtained from universal-stage measurements Syn: *stereo net*

**Würm** The fourth of the four classical glacial stages of the Pleistocene of Europe, above the Riss See also: *Wisconsin*

**wurtzite** (wurtz'-ite) A black massive infusible asphaltic pyrobitumen, insoluble in turpentine and derived from the metamorphism of petroleum

**wye level** A leveling instrument having a removable telescope, with attached spirit level, supported in Y-shaped rests, in which it may be rotated about its longitudinal axis, and from which it may be lifted and reversed, end for end, for testing and adjustment Cf *dummy level* Syn *Y-level*

## X

**X** In seismic prospecting, the distance from the shot point to the center of the spread, or to any particular geophone

**xeno-** A prefix meaning "stranger guest" Etymol. Greek

**xenoblast** (xen'-o-blast) A mineral that has grown in a rock during metamorphism without developing its characteristic crystal faces. It is a type of *crystalloblast*. Adj. *xenoblastic*. Cf. *idioblast*

**xenocryst** (xen'-o-cryst) A crystal that resembles a phenocryst in igneous rock but is foreign to the body of rock in which it occurs

**xenolith** (xen'-o-lith) A foreign inclusion in an igneous rock. Cf. *autolith*. Syn. *accidental inclusion*

**xenothermal** (xen'-o-ther-mal) Said of a hydrothermal mineral deposit formed at high temperature but shallow depth, also, said of that environment. Cf. *telethermal*, *hypothermal*

**xenotime** (xen'-o-time) A brown, yellow, or reddish tetragonal mineral,  $\text{YPO}_4$ . It often contains erbium, cerium and other rare earths, as well as thorium and uranium. Xenotime occurs as an accessory mineral in granites and pegmatites

**xenotopic** (xen'-o-top'-ic) Said of the fabric of a crystalline sedimentary rock in which the majority of the constituent crystals are anhedral. Also, said of an evaporite, a chemically deposited cement, or a recrystallized limestone or dolomite with such a fabric. Cf. *idiotopic*, *hypidiotopic*

**xerophyte** (xe'-ro-phyte) A plant with very low water requirements, a desert plant

**xerothermic period** (xe-ro-ther'-muc) A historical warm, dry period

**X-ray** Non-nuclear electromagnetic radiation of very short wavelength in the interval of 0.1-100 angstroms ( $10^{-11}$ - $10^{-8}$ m), i.e. between that of gamma rays and ultraviolet radiation. Also spelled *x-ray*

**X-ray diffraction** The diffraction of a beam of X-rays, usually by the three-dimensional periodic array of atoms in a crystal that has periodic repeat distances (lattice dimensions) of the same order of magnitude as the wavelength of the X-rays

**X-ray diffraction pattern** The characteristic interference pattern obtained when X-rays are diffracted by a crystalline substance. The geometry of the pattern is a function of the repeat distances (lattice dimensions) of the periodic array of atoms in the crystal, the intensities of the diffracted beams give information about the atomic arrangement and unit-cell dimensions. See also *electron diffraction pattern*

**xylopal** (xy-lo' pal) wood opal

## Y

**Yarmouth (Yar'-mouth)** Pertaining to the classical second interglacial stage of the Pleistocene Epoch in North America, after the Kansan glacial stage and before the Illinoian. Etymol: Yarmouth, a town in Iowa. See also: *Mindel-Riss*.

**yazoo stream (ya'-zoo)** A tributary that flows parallel to the main stream for a considerable distance before joining it at a deferred junction; esp. such a stream forced to flow along the base of a natural levee formed by the main stream. Type example: Yazoo River in western Mississippi, joining the Mississippi River at Vicksburg. Also spelled: Yazoo stream.

**yellow ground** Oxidized kimberlite of yellowish color found at the surface of diamond pipes (e.g. South Africa), above the zone of *blue ground*.

**yellow ochre** A mixture of limonite, usually with clay and silica, used as a pigment.

**yield point elastic limit.**

**yield stress** The differential stress at which permanent deformation first occurs in a material. Syn: *yield point; threshold pressure*.

**Y-level wye level.**

**yoked basin** *zeugogeosyncline*.

**young youthful.**

**younging facing.**

**Young's modulus** A *modulus of elasticity* in tension or compres-

sion, involving a change of length. It is expressed in dynes/cm<sup>2</sup> or lbs/ft<sup>2</sup>.

**young valley** A valley in its early stages, when it is relatively straight and has a high gradient, a V-shaped cross section, and short tributaries.

**youth 1.** The first stage in the development of a stream, during which it can carry a sediment load greater than the one it is actually carrying; is eroding downward rapidly in a V-shaped valley with falls and rapids, and has few short tributaries. 2. The first stage in the cycle of erosion, in which the original surface is still the dominant feature of relief. There are a few small young streams, broad, flat-topped divides; and poorly integrated drainage, with numerous swamps and lakes. Syn: *upographic youth*. 3. A stage in the development of a shore or coast characterized by an ungraded profile of equilibrium. For a shoreline of submergence: an irregular coast line with steep offshore profile, vigorous wave action, and the formation of bays, promontories, offshore islands, and sea cliffs. For a shoreline of emergence: a straight coast line, waves breaking well offshore, and the formation of barrier beaches, lagoons, and marshes.

**youthful** Said of a stream and its valley, or of a landscape or region, that is in the stage of *youth*. Syn: *young; juvenile*.

# Z

**zenith** (ze'-nith) The point on the celestial sphere that is directly above the observer and directly opposite to the *nadir*. In a more general sense, the term denotes the stretch of sky overhead.

**zenithal projection** (ze'-nith-al) *azimuthal projection*.

**zeolite** (ze'-o-lite) 1. A generic term for a large group of hydrous aluminosilicates that are analogous in composition to the feldspars; have a ratio of (Al + Si) to nonhydrous oxygen of 1:2; and are characterized by their easy and reversible loss of water of hydration and by their ready fusion and swelling when strongly heated. Zeolites have long been known to occur as well-formed crystals in cavities in basalt. Of more significance is their occurrence as *authigenic* minerals, esp. in beds of tuff. 2. Any of the minerals of the zeolite group, including natrolite, heulandite, analcime, and many others. 3. Any of various processed materials used in the base-exchange method of water softening and as gas adsorbents or drying agents.—Etymol: Greek *zein*, "to boil".

**zeugogeosyncline** (zeu'-go-ge'-o-syn'-cline) A *paraogeosyncline* with an adjoining uplifted area also in the craton, receiving clastic sediments; an intracratonic trough. Syn: *yoked basin*. Cf: *intracratonic basin*. Etymol: Greek *zeugos*, "paired, yoked".

**zigzag fold** A *kink fold*, the limbs of which are of unequal length.

Cf: *chevron fold*.

**zinc blende** *sphalerite*.

**zinc bloom** *hydrazincite*.

**zincite** (zinc'-ite) A hexagonal mineral, ZnO, usually containing some Mn. It is a minor ore of zinc.

**zinnwaldite** (zinn'-wald-ite) A mineral of the mica group,  $K_2(Li, Fe, Al)_6(Si, Al)_8O_{20}(OH, F)_4$ . It is a variety of lepidolite containing iron, and is the characteristic mica of *greisen*.

**zircon** (zir'-con) A mineral,  $ZrSiO_4$ . It occurs in tetragonal prisms, has various colors and is a common accessory mineral in siliceous igneous rocks, crystalline limestones, schists, and gneisses, in sedimentary rocks derived therefrom, and in beach and river placer deposits. It is the chief ore of zirconium, and is used as a refractory; when cut and polished, the colorless varieties provide exceptionally brilliant gemstones. Syn: *hyacinth*.

**zoarium** (zo-ar'-i-um) The skeleton of a bryozoan colony. Pl: *zoaria*.

**zoisite** (zo'-is-ite) An orthorhombic mineral of the epidote group,  $Ca_2Al_3Si_3O_{12}(OH)$ . Zoisite occurs in metamorphic rocks (esp. schists formed from calcium-rich igneous rocks), and in altered igneous rocks, and is an essential constituent of *saussurite*.

**zonal axis** (zon'-al) *zone axis*.

**zonal guide fossil** A *guide fossil* that makes possible the identification of a specific biostratigraphic zone and that gives its name to

**the zone** It need not necessarily be either restricted to the zone or found throughout every part of it  
**zonal soil** In early U.S. classification systems, one of the soil orders that embraces soils with well-developed characteristics that presumably reflect the influence of the agents of soil genesis, esp climate and plants, also, any soil belonging to the zonal order Cf *intrazonal soil*; *azonal soil*.  
**Syn** *mature soil*

**zonal theory** A theory of hypogene mineral-deposit formation, and the spatial distribution patterns of mineral sequences to be expected from change in a mineral-bearing fluid as it migrates away from a magmatic source. It also deals with thermal-chemical gradients associated with the genesis of ore deposits, and with metallogenic zoning on a regional scale. See also *zoning*.

**zonation (zo-nā'-tion)** The condition of being arranged or formed in zones, e.g. the distribution of distinctive fossils, more or less parallel to the bedding, in biostratigraphic zones

**zone 1** A belt or strip of earth materials, however disposed, distinguished from surrounding parts by some particular property or content, e.g. *fauit zone* or *zone of saturation*. **2** A minor interval in any category of stratigraphic classification, e.g. *biozone*, *lithozone*. **3** A metamorphic *aureole*. **4** A term used generally, even vaguely, for a region of latitudinal character more or less set off from

surrounding regions by some distinctive characteristic, e.g. the earth's torrid zone, two temperate zones, and two frigid zones

**zone axis** That line or crystallographic direction through the center of a crystal which is parallel to the intersection edges of the crystal faces defining the *crystal zone*. **Syn** *zonal axis*.

**zone of aeration** A subsurface zone containing water under pressure less than that of the atmosphere, including water held by capillarity, and containing air or gases generally under atmospheric pressure. This zone is limited above by the land surface and below by the surface of the zone of saturation, i.e., the *water table*.

**zone of capillarity** *capillary fringe*.

**zone of discharge** That part of the zone of saturation which has a means of horizontal escape

**zone of flow 1** *zone of plastic flow*

**2** The inner mobile main mass of a glacier, in which most of the ice flows without fracture Cf *zone of fracture*

**zone of fracture 1** The upper, brittle part of the earth's crust in which deformation is by fracture. **Syn** *zone of rock fracture* Cf *zone of plastic flow*. **2** The outer, rigid part of a glacier, in which the ice is much fractured Cf *zone of flow*

**zone of fracture and plastic flow**

That region of the earth's crust which is intermediate in depth and pressure between the zone of fracture and the zone of plastic flow in which deformation of the

weaker rocks is by plastic flow, and of the stronger rocks by fracture

**zone of mobility** *asthenosphere*.

**zone of plastic flow** That part of the earth's crust that is under sufficient pressure to prevent fracturing, i.e. is ductile, so that deformation is by flow Cf *zone of fracture*, *zone of fracture and plastic flow* Syn: *zone of flow*; *zone of rock flowage*

**zone of rock flowage** *zone of plastic flow*.

**zone of rock fracture** *zone of fracture*.

**zone of saturation** A subsurface zone in which all the interstices are filled with water, under pressure greater than that of the atmosphere. Although the zone may contain gas-filled interstices or interstices filled with fluids other than water it is still considered saturated. This zone is separated from the overlying zone of aeration by the *water table*. Syn: *saturated zone*, *phreatic zone*

**zone of weathering** The superficial layer of the earth's crust above the water table that is subjected to the destructive agents of the atmosphere, and in which soils develop

**zoning** 1 A variation in the composition of a crystal from core to margin, owing to a separation of crystal phases during growth by loss of equilibrium in a continu-

ous reaction series. The higher-temperature phases form the core, with the lower-temperature phases toward the margin. See also: *normal zoning*; *reversed zoning*. 2 The development of areas of metamorphosed rocks in which a particular mineral or mineral suite is predominant or characteristic, reflecting the history of the rock. 3 The distribution patterns of elements or minerals around ore deposits, paragenetic sequences, either syngenetic or epigenetic. See also: *zonal theory*

**zoocology** (zo'-o-e-col'-o-gy) The branch of ecology concerned with the relationships between animals and their environment

**zoogenic rock** (zo-o-gen'-ic) A biogenic rock produced by animals or directly attributable to the presence or activities of animals; e.g. shell limestone, coral reefs, guano, and lithified calcareous ooze

**zooplankton** (zo-o-plank'-ton) The animal forms of plankton, e.g. jellyfish. They consume the *phytoplankton*.

**Z phenomenon** A possible time lag (a few seconds or less) between the issuance of P and S waves from an earthquake focus

**zweikanter** (zwei'-kan-ter) A ventifact having two faces intersecting in two sharp edges. Etymol. German *Zweikanter*, "one having two edges"





TABLE A-1

## Basic crystal systems\*

Crystal shape†

Name description

Typical forms of common mineral crystals



Isometric three equal length axes—all at right angles



Garnet



Magnetite



Halite pyrite



Tetragonal two equal axes and a third either longer or shorter—all at right angles



Zircon



Hexagonal three equal axes in same plane intersecting at 60° a fourth perpendicular to other three



Quartz



Calcite dolomite



Hematite



Orthorhombic three unequal axes—all at right angles



Olivine



Aragonite



Monoclinic three unequal axes—two at right angles to a third perpendicular to one but oblique to the other



Pyroxene



Mica clay



Orthoclase



Gypsum



Triclinic three unequal axes—all at oblique angles



Plagioclase



Calcium aluminum silicate

TABLE A-2

## Mohs scale of hardness

Hardness	Mineral	Test
1	Talc	(Softest)
2	Gypsum	
2.5		Fingernail
3	Calcite	Copper coin
6	Fluorite	
4	Apatite	
5.5-6		Knife blade or plate glass
6	Orthoclase	
6.5-7		Steel file
7	Quartz	
8	Topaz	
9	Corundum	
10	Diamond	(Hardest)

TABLE A 3

**Minerals arranged according to hardness**

Hardness	Mineral	Hardness	Mineral
1	Talc	5-6	Tremolite
1-2	Graphite	5 5	Chromite
1-3	Bauxite	5 5	Enstatite
2	Gypsum	5 5	Uraninite
2	Stibnite	5 5-6	Anthophyllite
2-2 5	Chlorite	5 5-6 5	Hematite
2-2 5	Kaolinite	6	Albite
2-2 5	Muscovite	6	Anorthite
2-5	Serpentine	6	Arvedsonite
2 5	Galena	6	Magnetite
2 5	Halite	6	Orthoclase
2 5-3	Biotite	6-6 5	Aegirite
2 5 3	Chalcocite	6-6 5	Pyrite
3	Bornite	6-7	Cassiterite
3	Calcite	6-7	Epidote
3-3 5	Anhydrite	6-7	Sillimanite
3 5-4	Chalcopyrite	6 5-7	Jadeite
3 5-4	Dolomite	6 5-7	Olivine
3 5-4	Siderite	6 5 7	Spodumene
3 5	Sphalerite	6 5 7 5	Almandite
4	Azurite	6 5-7 5	Garnet
4	Fluorite	7	Kyanite (across crystal)
5	Apatite	7	Quartz
5	Kyanite (along crystal)	7-7 5	Staurolite
5-5 5	Goethite	7 7 5	Tourmaline
5 5 5	Limonite	7 5	Andalusite
5-5 5	Wollastonite	7 5	Zircon
5-6	Actinolite	8	Spinel
5-6	Augite	8	Topaz
5-6	Dioptase	9	Corundum
5-6	Hornblende	10	Diamond
5-6	Opal		

TABLE A 4

**Minerals arranged according to specific gravity**

Specific gravity	Mineral	Specific gravity	Mineral
1.9-2.2	Opal	3.3-3.5	Jadeite
2.0-3.0	Bauxite	3.3-4.37	Goethite
2.16	Halite	3.35-3.45	Epidote
2.2-2.65	Serpentine	3.4-3.55	Aegirite
2.3	Graphite	3.4-3.6	Topaz
2.32	Gypsum	3.45	Arfvedsonite
2.57	Orthoclase	3.5	Diamond
2.6	Kaolinite	3.5-4.1	Spinel
2.6-2.9	Chlorite	3.5-4.3	Garnet
2.62	Albite	3.56-3.66	Kyanite
2.65	Quartz	3.6-4.0	Limonite
2.7-2.8	Talc	3.65-3.75	Staurolite
2.72	Calcite	3.77	Azurite
2.76	Anorthite	3.85	Siderite
2.76-3.1	Muscovite	3.9-4.1	Sphalerite
2.8-2.9	Wollastonite	4.0	Carnotite
2.8-3.2	Biotite	4.02	Corundum
2.85	Dolomite	4.1-4.3	Chalcopyrite
2.85-3.2	Anthophyllite	4.25	Almandite
2.89-2.98	Anhydrite	4.52-4.62	Stibnite
3.0-3.25	Tourmaline	4.6	Chromite
3.0-3.3	Actinolite	4.68	Zircon
3.0-3.3	Tremolite	5.02	Pyrite
3.15-3.2	Apatite	5.06-5.08	Bornite
3.15-3.2	Spodumene	5.18	Magnetite
3.16	Andalusite	5.26	Hematite
3.18	Fluorite	5.5-5.8	Chalcocite
3.2	Hornblende	6.8-7.1	Cassiterite
3.2-3.4	Augite	7.4-7.6	Galena
3.2-3.5	Enstatite	9.0-9.7	Uraninite
3.23	Sillimanite		
3.27-3.37	Olivine		

TABLE A 5

**Scale of fusibility**

Scale	Mineral	Approx fusing point °C	Remarks
1	Stibnite	525	Easily fusible in candle flame
2	Chalcopyrite	800	Small fragment easily fusible in Bunsen-burner flame
3	Garnet (almandite)	1050	Infusible in Bunsen flame but easily fusible in blowpipe flame
4	Actinolite	1200	Sharp-pointed splinter fuses with little difficulty in blowpipe flame
5	Orthoclase	1300	Fragment edges rounded with difficulty in blowpipe flame
6	Bronzite	1400	Only fine splinter ends rounded in blowpipe flame
7	Quartz	1470	Infusible in blowpipe flame

TABLE A 6

**Plagioclase feldspars**

Species	Albite, %	Anorthite, %
Albite, $\text{Na}(\text{AlSi}_3\text{O}_8)$	100-90	0- 10
Oligoclase	90-70	10- 30
Andesine	70-50	30- 50
Labradorite	50-30	50- 70
Bytownite	30-10	70- 90
Anorthite, $\text{Ca}(\text{Al}_2\text{Si}_2\text{O}_8)$	10- 0	90-100

TABLE A 7

**Ions in common pyroxenes and amphiboles**

Ions

X	Y	Pyroxenes <sup>a</sup>	Amphiboles <sup>b</sup>
Mg	Mg	Enstatite	Anthophyllite
Ca	Mg	Diopside	Tremolite
Li	Al	Spodumene	
Na	Al	Jadeite	Glaucophane
Na	Fe <sup>3+</sup>	Aegirite	Arfvedsonite
Ca, Na	Mg, Fe, Mn, Al, Fe <sup>3+</sup> , Ti	Augite	Hornblende

<sup>a</sup>Basic structure single chain, SiO<sub>3</sub> formula XY(Si<sub>2</sub>O<sub>6</sub>)<sup>b</sup>Basic structure double chains Si<sub>4</sub>O<sub>11</sub>, formula X<sub>0-7</sub>Y<sub>7-14</sub>Z<sub>16</sub>O<sub>44</sub>(OH)<sub>4</sub>**MINERAL CHARACTERISTICS****CRYSTAL SYMMETRY AND SYSTEMS**

As noted in Chapter 2, when a mineral grows without interference it is bounded by plane surfaces symmetrically arranged, which give it a characteristic crystal form. This form is the external expression of its definite internal crystalline structure. The faces of crystals are defined by surface layers of atoms.

Every crystal consists of atoms arranged in a three dimensional pattern that repeats itself regularly. Even in irregular mineral grains the atoms are arranged according to their typical crystalline structure.

Crystals are classified in six different systems according to the symmetry of their faces and the arrangement of their axes of symmetry. (An axis is an imaginary straight line that is drawn from the center of a face to the center of the opposite face.) The systems are described and illustrated in Table A 1.

**HARDNESS**

We can determine the hardness of a mineral by scratching its smooth

surface with the edge of another. We must be sure that the mineral tested is actually scratched. Sometimes particles simply rub off the specimen, suggesting that it has been scratched even though it has not.

In Table A 2 ten common minerals have been arranged as examples of the degrees of the Mohs scale of relative hardness. Each of these minerals will scratch all those lower in number on the scale and will be scratched by all those higher. In other words this is a *relative scale*. In terms of absolute hardness the steps are approximately uniform up to 9, that is, number 7 is 7 times as hard as 1 and 9 is 9 times as hard as 1. But 10 is about 40 times as hard as 1. A more extensive listing is in Table A 3 (and in Table A 8).

## MAGNETISM

Minerals that in their natural state are attracted to a magnet are said to be *magnetic*. Magnetite  $\text{Fe}_3\text{O}_4$ , and pyrrhotite  $\text{Fe}_{1-x}\text{S}$  with  $x$  between 0 and 0.2 are the only common magnetic minerals although many others containing iron are drawn to a sufficiently powerful electromagnet.

## PYROELECTRICITY

Pyroelectricity is the simultaneous development of positive and negative charges of electricity on different parts of the same crystal under the proper conditions of temperature change. Quartz is a good example. If it is heated to about  $100^\circ\text{C}$  it will, on cooling, develop positive electric charges at three alternate prismatic edges and negative charges at the other three edges.

## PIEZOELECTRICITY

Piezoelectricity is that of a charge developed in a crystallized body by pressure. Quartz is probably the most important piezoelectric mineral, for an extremely slight pressure parallel to its electric axis can be detected by the electric charge set up. It is used in specially oriented plates in radio equipment and in sonic sounders.

## LUSTER

Luster is the way a mineral looks in reflected light. There are several kinds of luster.

**Metallic** Of metals  
**Adamantine** Of diamonds  
**Vitreous** Of a broken edge of glass  
**Resinous** Of yellow resin  
**Pearly** Of pearl  
**Silky** Of silk

## FLUORESCENCE AND PHOSPHORESCENCE

Minerals that become luminescent during exposure to ultraviolet light, X rays, or cathode rays are *fluorescent*. If the luminescence continues after the exciting rays are shut off, the mineral is said to be *phosphorescent*.

## FUSIBILITY

Minerals can be divided into those fusible and those infusible in a blowpipe flame. Seven minerals showing different degrees of fusibility have been used as a scale to which fusible minerals can be referred. They are listed in Table A-5.

## SOLUBILITY

Concentrated hydrochloric acid (HCl) diluted with three parts of water, is commonly used for the solution of minerals being tested. Other wet reagents are for special tests to help identify minerals.

## FRACTURE

Many minerals that do not exhibit cleavage (Chapter 2) break or fracture in a distinctive manner. Some types of fracture are

**Conchoidal** Along smooth curved surfaces like the surface of a shell ("conch"), commonly observed in glass and quartz.

**Fibrous or splintery** Along surfaces roughened by fibers or splinters.

**Uneven or irregular** Along rough, irregular surfaces.

**Hackly** Along a jagged, irregular surface with sharp edges.

## TENACITY

A mineral's cohesiveness, as shown by its resistance to breaking, crushing, bending, or tearing is known as its *tenacity*. Various kinds of tenacity in minerals include the following:

**Brittle** Breaks or powders easily

**Malleable** Can be hammered into thin sheets

**Sectile** Can be cut by a knife into thin shavings

**Ductile** Can be drawn into wire

**Flexible** Bends but does not return to its original shape when pressure is removed

**Elastic** After being bent will resume its original position upon release of pressure

## IMPORTANT MINERALS

### SILICATES

More than 90 percent of rock-forming minerals are silicates, with structures based on the  $(\text{SiO}_4)^4-$  tetrahedron. ~~Important classes are listed in Table 2.3 on page 29.~~

### PLAGIOCLASE FELDSPARS

The plagioclase feldspars, also called the *soda-lime feldspars*, form a complete solid-solution series from pure albite to pure anorthite.

Calcium substitutes for sodium in all proportions, with accompanying substitution of aluminum for silicon. The series is divided into the six arbitrary species names listed in Table A.6 (also see Table A.8).

### PYROXENES AND AMPHIBOLES

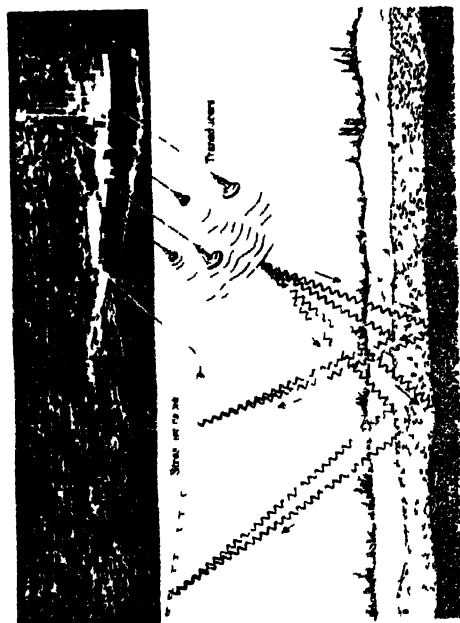
The pyroxene family of minerals and the amphibole family of minerals are *inosilicates* that parallel each other. The amphiboles contain OH. The pyroxenes crystallize at higher temperatures than their amphibole analogues. The two are in Table A.7.





FIGURE 12.8

Fast d surges along the Yonart glacier in the  
Kaskade Range have displaced moraine loops  
down valley. The photograph was taken in 1964  
and the latest surge at that time had been in 1942  
for retreat of Washington on Austin Peak.]



Stream is not bearing millions  
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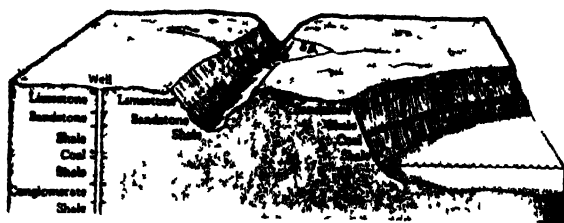
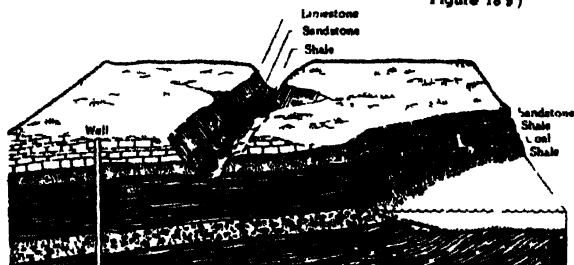
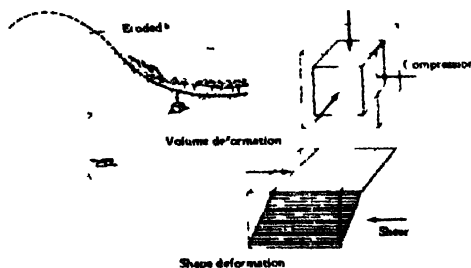


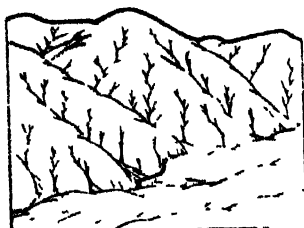
Diagram to illustrate the data that might be used to correlate sedimentary rocks (right) in a sea cliff with those (center) in a stream valley and with those (left) encountered in a well drilling operation. (See also Figure 18.9)



Similar lithologies and sequences of beds in the three different localities of Figure 18.8 suggest the correlation of rock layers shown in the diagram.

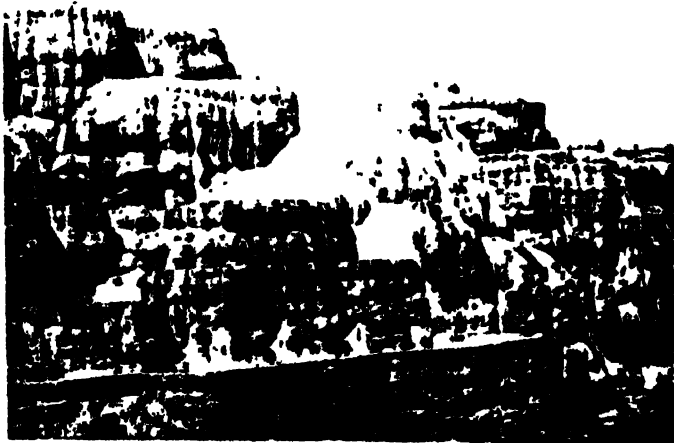


Deformation may produce change in volume without change in shape or change in shape without change in volume or a combination of the two.

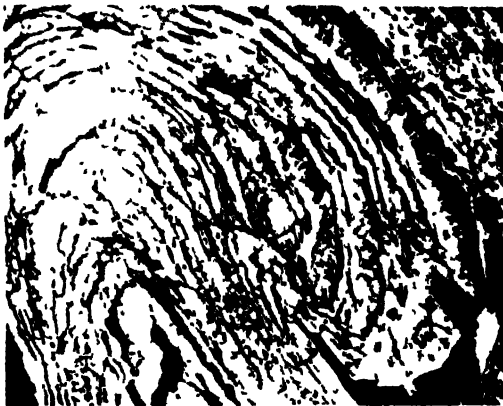


The progressive development of cirques, horns, arêtes, and cols (a) Valley glaciers have produced cirques, but since erosion has been moderate, much of the original mountain surface has been unaltered by the ice. The result of more extensive glacial erosion is shown in (b). In (c) glacial erosion has affected the entire mass and has produced not only cirques but also a horn, jagged knife-edged arêtes, and cols. [Redrawn from William Morris Davis, "The Colorado Front Range," *Ann. Assoc. Am. Geol.*, vol. 1, p. 57, 1911.]

A mountainous area before, during, and after glaciation. Redrawn from William Morris Davis, "The Sculpture of Mountains by Glaciers," *U.S. Geol. Mag.*, vol. 22, pp. 80-81, 83, 1906.

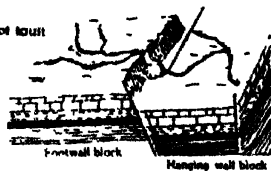


Mammoth Hot Springs, Yellowstone National Park are thermal springs that have built these terraces by depositing travertine (US Geological Survey)



This aerial photograph shows the twisted pattern of deformed and metamorphosed rocks. The beds, which show as bands 100 to 300 m wide, were once horizontal sedimentary rocks. They were deeply buried beneath the surface, tilted and folded by earth forces, and then exposed to view by subsequent erosion (Royal Canadian Air Force)

Types of fault



Normal fault



Thrust fault



Left lateral strike-slip fault



Right lateral strike-slip fault



Oblique-slip fault



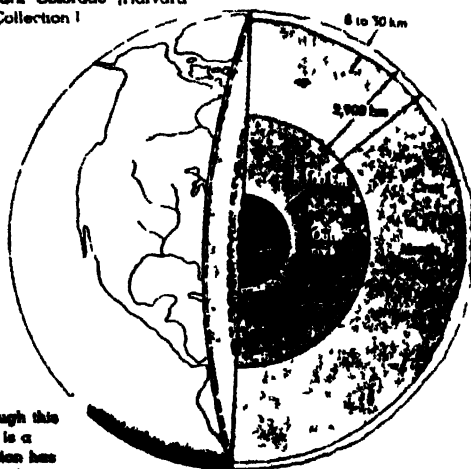
Hinge fault



Profile of one of the world's most nearly perfect conic cones. Mayon, on Luzon. (Harvard University Gardner Collection)



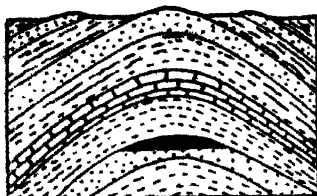
A conglomerate is made up of rounded pebbles as shown in this deposit of partially consolidated material in Estes Park Colorado (Harvard University Tazewell Collection)



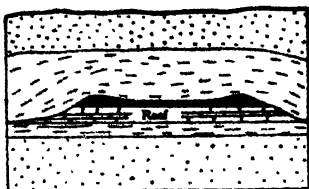
The sea has cut arches through this promontory To the far right is a stack a rock mass that erosion has cut off from the mainland. Arches State Park, California. (Sheldon Jackson)

Structure of the mantle and core

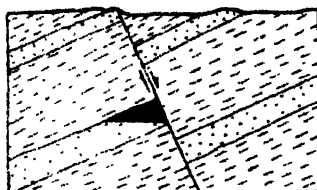




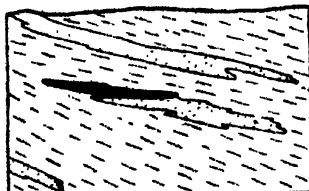
(a)



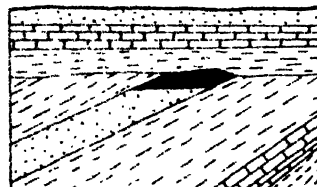
(b)



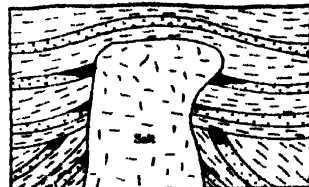
(c)



(d)

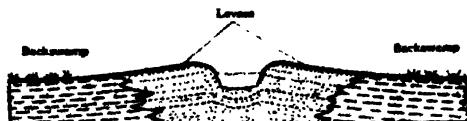


(e)



(f)

The common types of oil traps, drawn here in cross section, include (a) anticlines, (b) faults, (c) unconformities, (d) roots, (e) sand lenses, and (f) salt domes. Oil accumulation is shown in color.



Natural levees characterize many aggrading streams. They build up during periods of flood as coarser material is deposited closest to the stream channel to form the levee and finer material is deposited in the back swamps. As the banks build up, the floor of the channel also rises.



The Starbuck slope of the American Falls at Niagara Falls reveals more than the present day land pattern. (Photographed & used understanding of June 1980 for Niagara power project) [State of New York Power Authority];



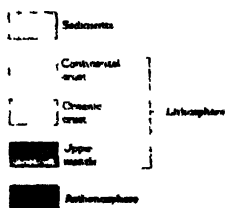
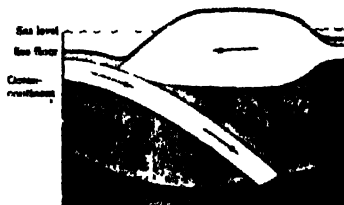
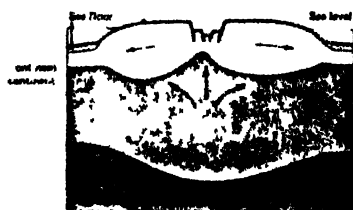
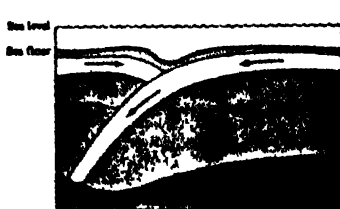
Layering is a characteristic of sedimentary rocks. Here, in Pueblo County, Colorado, beds of limestone alternate with layers of shale, slightly recessed because they weather more rapidly [G. K. Gilbert].



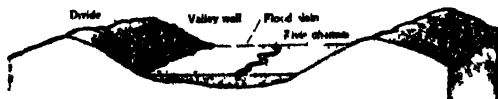
Divergent boundaries



Convergent boundaries



Illustrations of plate boundaries and their interactions with other plates. (From various sources)



(a)



(b)



Cross section of a river valley. The major features of a river valley in cross section include the divide, valley walls, river channel, and in some instances flood plain. Divides may be flat topped or rounded or narrow.

Peridot Volcano on the Alaska Peninsula (US Navy)

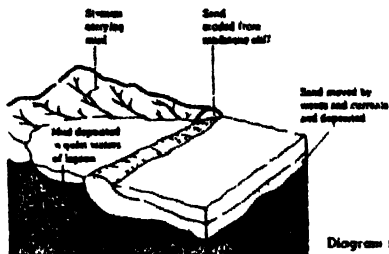
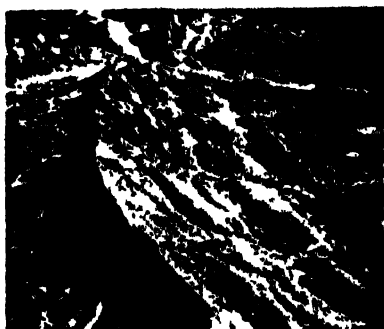


Diagram to illustrate a change in sedimentary facies. Here the fine-grained muds are deposited in a lagoon close to shore. A sandbar separates them from sand deposits further away from shore. The sand in this instance has been derived from a sea cliff and transported by waves and currents.



(a)



(b)

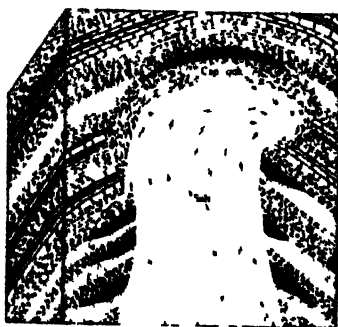
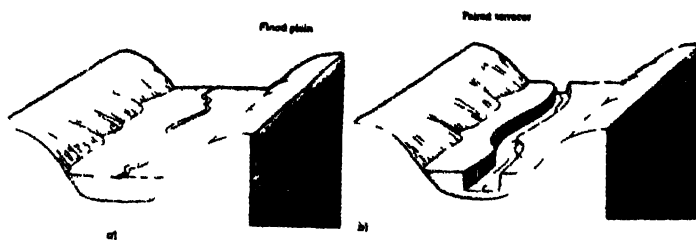
**Dip and strike** (a) Photograph showing outcropping edges of tilted beds in southwestern Colorado a few kilometers east of Durango (b) Sketch illustrating terms used to describe the attitude of these beds. The beds strike north and dip 30° east [U.S. Department of Agriculture Soil Conservation Service]



**Stalactites** grow downward; some to meet stalagmites growing upward from the cave floor in Carlsbad Caverns, New Mexico [National Park Service]



Delicate corallike forms have been deposited on a massive stalagmite in the Queen's Chamber, Catalhoyuk Caverns, New Mexico. [N. Stogor, Park Service.]

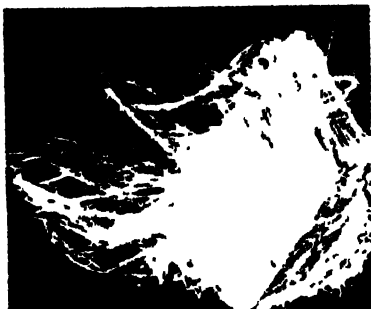
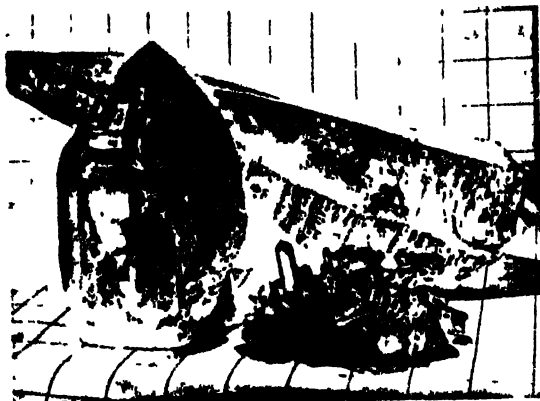


One example of the formation of paired terraces. (a) The stream has partially filled its valley and has created a broad flood plain. (b) Some change in conditions has caused the stream to erode into its own deposits; the remnants of the old flood plain stand above the new river level as terraces of equal height.

Schematic diagram of a salt dome.

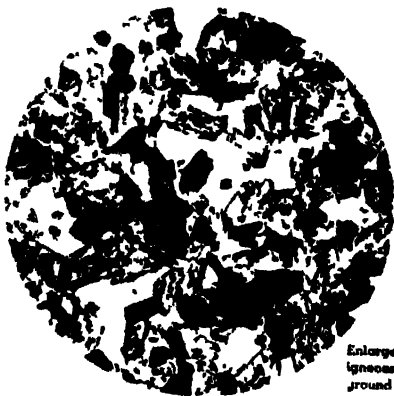


A small volcanic cone in the crater of Vesuvius near Naples, Italy, belches out an ash laden cloud of hot gases. This volcano is one of a chain of volcanoes, both active and extinct, that reaches from Mount Etna in Sicily to north of Rome far up the Italian boot. They all represent features built by molten material periodically extruded through the earth's crust. [Vincenzo Caracciolo.]

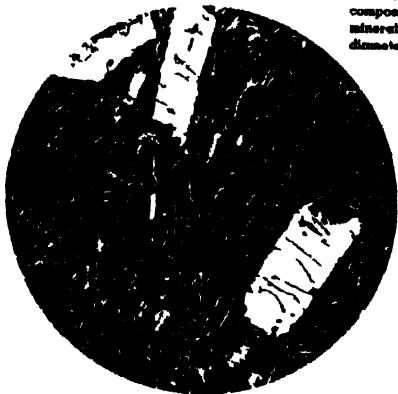


Quartz crystals. Regardless of the shape or size of crystals, the angles between true crystal faces remain the same. Transverse striations on prism faces are most clearly seen on the two large crystals, which also carry blotches of foreign matter, but striations are present on the faces of the other crystals, too. The large stubby crystal from Loup, Ind., France, is about 35 cm. tall. The other crystals are from Brazil. (U.S. National Museum.)

Chrysotile asbestos, a fibrous variety of serpentine from Thetford, Quebec. (Benjamin M. Shubert.)

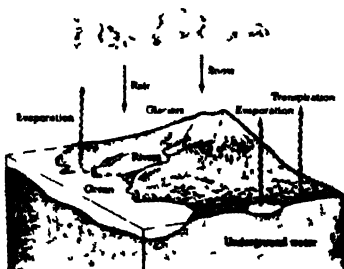


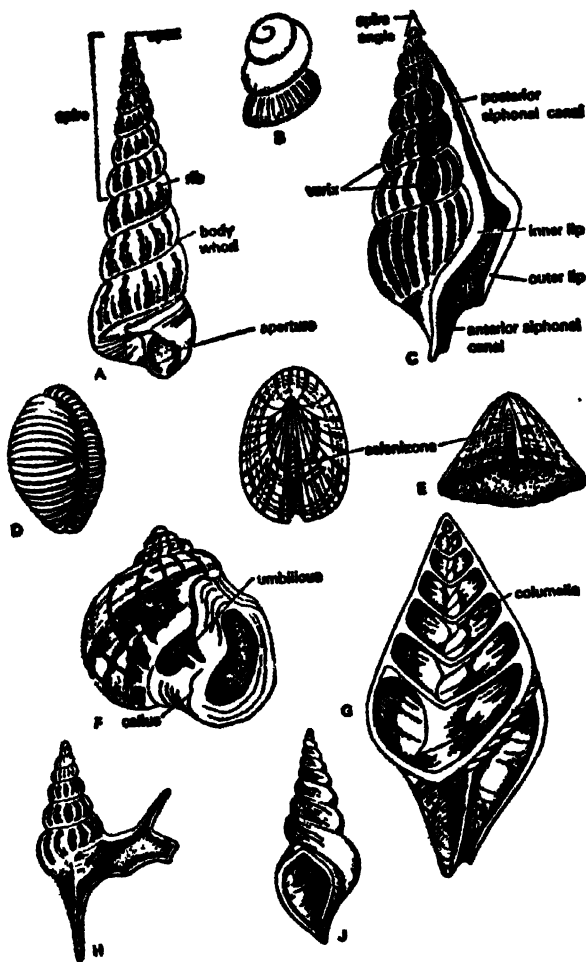
Enlarged photograph of a piece of granular igneous rock taken through a slice that has been ground to translucent thinness (known as a *thin section*). The photograph shows the rock to be composed of interlocking crystals of different minerals. (Field of view approximately 0.5 cm in diameter.)



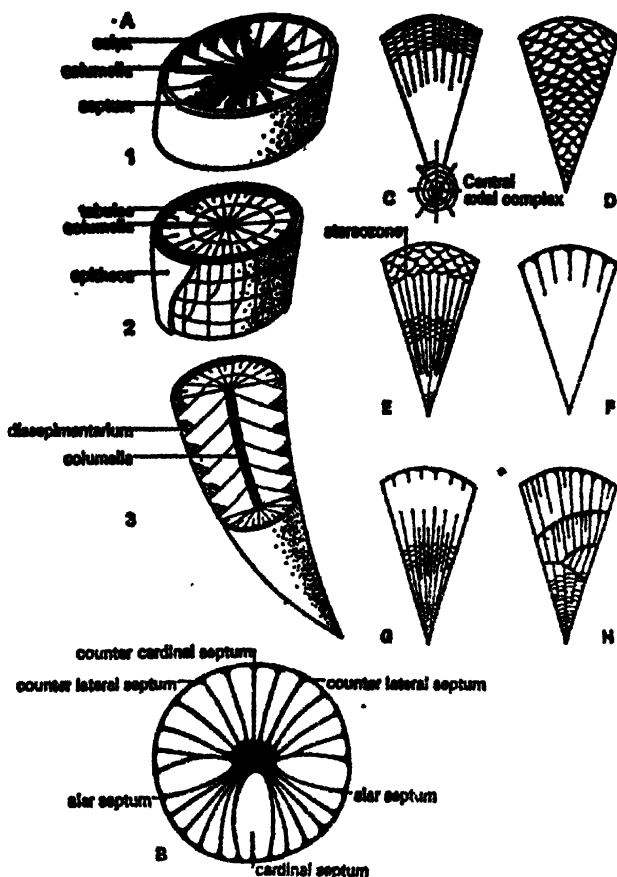
Enlarged photograph of a thin section of porphyritic igneous rock. (Largest crystal approximately 0.125 cm by 0.25 cm.)

In the hydrologic cycle water evaporated into the atmosphere reaches the land as rain or snow. Here it may be temporarily stored in glaciers, lakes, or the underground before returning by the rivers to the sea. Or some may be transpired or evaporated directly back into the atmosphere before reaching the sea.





**100** Morphology displayed by various gastropod shells. (A) and (C) General descriptive terms, (a) Enlargement of protoconch; (b) *Triva*; (a) Patella-type gastropod showing selenizone; (F) *Natica*; (G) Longitudinal section of a gastropod showing the columella, internal structure, and coiling; (H) *Apporrhais*, showing apertural spine and digitation; (J) Sinistrally coiled shell - the aperture appears on the left (cf. dextral coiling in A, C, F, and H).



■. Rugose corals. (A) A simple rugose coral to show morphology; (B) Section; (C-H) Variations of septal plan and development of the dissepimentarium; (C) Outer dissepimentarium, central axis complex, and septa withdrawn from centre (Clisiophylloid); (D) All dissepimentarium, no septa (Cystiphylloid); (E) Septa with median dissepimentarium and outer stereozone; (F) No dissepiments, septa withdrawn from centre (Amplexoid); (G) Septa disappearing at margin, central and median dissepiment zone (Lonsdaleoid); (H) Strong development of tabulae with short discoidal septa; central dissepiment zone.





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